ARMY ORDNANCE

VOL. XXIV, No. 136 JANUARY-FEBRUARY, 1943

Communications in Global War
Maj. Gen. Dawson Olmstead

Our Tanks Meet the Test
Maj. Gen. C. L. Scott

Artillery Today
Maj. Gen. H. Rowan-Robinson

The Ordnance Reorganization
Col. J. C. Raaen

Integration for Production
Brig. Gen. A. R. Glancy

Maintenance Regiments
Col. C. Wingate Reed

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

HERE'S WHY *Scrap* IS SO IMPORTANT!

SCRAP iron or steel turnings, clippings, short ends, worn out or broken tools, spoiled work, idle and obsolete machinery, etc., are valuable as raw materials for remelting in the production of new steel.

Through previous refining, ingredients undesirable in steel have been reduced—thus the use of properly prepared scrap speeds the refining process and enables new steels to be produced more rapidly. Recapture of scrap—from your plant—means opportunity to save time and labor—hence more steel.

Certain scrap contains valuable alloying elements such as nickel, molybdenum, tungsten, etc. which can and must be recovered to augment primary supply to meet tremendously increased demand for constructional and high speed alloy steels for more planes, tanks, guns, ships, tools and machinery essential to the war effort.

To be of maximum immediate assistance, scrap should be segregated by composition wherever possible. Turnings, spoiled work etc. should be identified (SAE, AISI, NE etc. grade number) at the machine where they are generated and so handled as to avoid contamination by waste material or scrap of other types and grades.

The metallurgical experience of our staff is available to aid you in technical phases of metal salvage.

KEEP SCRAP MOVING INTO WAR PRODUCTION!

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Founded 1920

For Victory through Armament Research, Production, and Supply

Volume XXIV JANUARY-FEBRUARY, 1943 No. 136

CONTENTS

16-Inch Gun Tube		Frontispiece
Communications in Global War	Maj. Gen. Dawson Olmstead	59
The Ordnance Reorganization	Col. J. C. Raaen	63
The Ordnance Department (Chart)	*Facing*	64
Our Tanks Meet the Test	Maj. Gen. C. L. Scott	67
Integration for Production	Brig. Gen. A. R. Glancy	72
Artillery Today	Maj. Gen. H. Rowan-Robinson	73
Maj. Gen. William Crozier	(An Obituary)	77
Heavy Ordnance	(Pictorial)	81
Circassia—Key to Conquest	Brian O. Lisle	89
Maintenance Regiments	Col. C. Wingate Reed	94
Protection against Sabotage	R. W. Reynolds	96
Standard Surface Finishes	Lieut. Col. William J. Darmody	99
Month by Month		102
Membership in the Army Ordnance Association	*Facing*	104
Association Affairs		105
Ordnance in Review	Lieut. Col. Calvin Goddard	107
Preventive Maintenance		110
Professional Digest		112
Aërial Gunnery		118
New Developments		120
From the Record		126
Book Reviews		128
Index of Advertisements		202

(Publication date: December 26, 1942)

Published by the Army Ordnance Association, Suite 705, Mills Building, Washington, D. C. Editor: Brig. Gen. R. H. Somers, U.S. Army, Ret.; Associate Editor: R. E. Lewis, Jr. Authors are responsible for statements and opinions expressed in their articles. Copyright, 1942, by the Army Ordnance Association, Washington, D. C. Permission for republication in whole or in part must be obtained in advance.

Issued bimonthly. Single copy 75c (by mail). Subscription rate: continental U. S. and possessions, $4.50 annually, in advance. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Three weeks' notice before publication date of next issue required for change of address.

THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of more than 13,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-two years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is being geared rapidly for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 104.) There are twenty local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

Officers

President: BRIG. GEN. BENEDICT CROWELL, Cleveland, Ohio
Vice-President: COL. WILLIAM W. COLEMAN, Milwaukee, Wis.
Vice-President: COL. FREDERICK H. PAYNE, Greenfield, Mass.
Vice-President: COL. JAMES L. WALSH, New York, N. Y.
Treasurer: BRIG. GEN. CHAS. ELLIOT WARREN, New York, N. Y.
Counsel: BRIG. GEN. JOHN ROSS DELAFIELD, New York, N. Y.

Directors

COL. BRUCE CORNWALL, San Francisco, Calif.
MR. W. C. DICKERMAN, New York, N. Y.
MR. J. B. DOAN, Cincinnati, Ohio
MR. GEORGE W. ELLIOTT, Philadelphia, Pa.
COL. HERBERT A. GIDNEY, Pittsburgh, Pa.
MR. EARL B. GILMORE, Los Angeles, Calif.
MR. T. M. GIRDLER, Cleveland, Ohio
COL. ARTHUR W. HERRINGTON, Washington, D. C.
COL. ROBERT P. LAMONT, New York, N. Y.
BRIG. GEN. SAMUEL MCROBERTS, New York, N. Y.
MR. THOMAS A. MORGAN, New York, N. Y.
MR. EDMUND A. RUSSELL, Chicago, Ill.
COL. FRANK A. SCOTT, Cleveland, Ohio
COL. HARRY SCULLIN, St. Louis, Mo.
COL. THEODORE SWANN, Birmingham, Ala.
COL. CHARLES H. TENNEY, Springfield, Mass.
COL. JAMES L. WALSH, New York, N. Y.

Executive Secretary: BRIG. GEN. R. H. SOMERS, U. S. Army, Ret.
Assistant Secretary: FLORENCE G. FERRITER
Executive Offices: Mills Building, Pennsylvania Avenue at 17th Street, Washington, D. C.

LOCAL POSTS OF THE ASSOCIATION

The Officers, Charter Dates, and Headquarters of the Twenty Chapters

Birmingham, December 3, 1930.—President: Theodore Swann. Vice-President: Lindley C. Morton. Directors: Thomas Martin, Oscar Wells, Hugh Morrow, W. D. Moore, Erskine Ramsay, L. E. Geohegan, Wade H. Oldham, R. C. Stobert. Treasurer: Richard J. Stockham. Secretary: E. C. Bomar, 700 Frank Nelson Building, Birmingham, Ala.

Boston, June 30, 1925.—President: Carl P. Dennett. Vice-President: H. P. Richardson. Directors: T. L. Ames, R. J. Thanisch, M. T. Carney, A. E. Anderson, C. E. Fuller, W. Van Pattensteiger, R. E. Goho. Secretary-Treasurer: Philip E. Gruber, 140 Federal Street, Boston, Mass.

Chicago, May 3, 1924.—President: Edmund A. Russell. Vice-President: F. W. Parker, Jr. Directors: W. E. Crocombe, W. H. Damon, T. S. Hammond, Sterling Morton, Fred A. Preston, W. R. Wright. Treasurer: G. V. Rountree. Assistant Secretary: F. W. Renwick, Jr. Secretary: J. W. Cavanaugh, 38 S. Dearborn Street, Chicago, Ill.

Cincinnati, December 10, 1925.—President: August H. Tuechter. Vice-President: A. H. Pugh. Directors: E. A. Muller, F. L. Burke, C. W. Wheland, Louis Schwitzer, F. V. Geier, A. F. Hubbard, H. C. Knowles, C. H. Kindl. Secretary: Fred A. McMahon, Big Four Building, Cincinnati, Ohio.

Cleveland, October 25, 1940.—President: Clifford F. Hood. Vice-Presidents: John C. McHannan, Rufus J. Wysor. Directors: Robert F. Black, Hosea T. Bradner, Ward M. Canaday, Fred Chapin, Frederick C. Crawford, Ben F. Hopkins, Adrian D. Joyce, Frank Purnell, Edward J. Thomas. Secretary-Treasurer: Harold M. Reedall, 1450 Terminal Tower, Cleveland, Ohio.

Hartford-Springfield, November 18, 1941.—President: Frederick H. Payne. Vice-President: C. H. Granger. Directors: H. C. Beaver, E. P. Bullard, E. B. Gallaher, S. C. Hope. Secretary-Treasurer: G. H. Drewry, 95 State Street, Springfield, Mass.

Lehigh-Bethlehem, November 15, 1939.—President: Howard V. Donohoe. 1st Vice-President: R. B. Gerhardt. 2nd Vice-President: John D. Van Blarcom. Treasurer: Theodore G. Scott, Jr. Secretary: Robert G. Taylor, 406 Delaware Avenue, Bethlehem, Pa.

Los Angeles, May 27, 1936.—President: Earl B. Gilmore. Vice-President: Donald Douglas. Directors: W. H. Adams, A. R. Baird, Ralph O. Cragin, H. S. Hitchcock, M. A. Koffman, M. M. Mitchell, F. B. Cole, K. T. Norris. Treasurer: Samuel K. Rindge. Secretary: Ralph C. Scott. Assistant Secretary: D. W. Allison, 409 Chamber of Commerce Building, Los Angeles, Calif.

Massachusetts Institute of Technology, January 20, 1922.—President: James A. Mallock. Vice-President: William J. Cochran. Secretary-Treasurer: Frank E. French, Jr., 389 Marlboro Street, Boston, Mass.

Milwaukee, September 26, 1928.—President: W. W. Coleman. Vice-President: J. E. DeLong. Directors: Pierpont J. E. Wood, Roger Sherman Hoar, H. Stanley Johnson, Jr., D. P. Davies, Max W. Babb, H. V. Kohler, Frank R. Bacon, Harold Falk, Robert A. Uihlein. Secretary-Treasurer: F. O. Wyse, Bucyrus-Erie Company, So. Milwaukee, Wis.

New York, June 15, 1921.—President: R. E. Gillmor. 1st Vice-President: Crosby Field. 2nd Vice-President: James E. McNary. 3rd Vice-President: Thomas E. Murray. 4th Vice-President: H. M. Tillinghast. Executive Committee: The officers and Thomas F. Brown, A. E. Van Cleve, W. C. Dickerman, Charles J. Hardy, Carl W. Keuffel, Frank Johnson. Treasurer: James E. McNary. Secretary: C. B. F. Brill, 80 Broadway, New York, N. Y.

Philadelphia, December 9, 1926.—President: C. Jared Ingersoll. Vice-Presidents: William D. Disston, George W. Elliott. Directors: E. G. Budd, D. K. Bullens, R. A. Cannon, W. D. Disston, G. W. Elliott, L. E. Hess, S. F. Laucks, E. J. Longstreth, Walter F. Perkins, W. Wear. Secretary-Treasurer: D. N. Hauseman, 1300 Mitten Building, Philadelphia, Pa.

Pittsburgh, February 24, 1927.—President: Herbert A. Gidney. Vice-Presidents: C. W. Heppenstall, James L. Guion. Directors: Frank B. Bell, G. M. Sixsmith, S. L. Goodale, F. A. Merrick, W. F. Detwiler, J. D. Berg. Secretary-Treasurer: Thomas H. Eddy, 1202 Chamber of Commerce Building, Pittsburgh, Pa.

Rochester, April 29, 1938.—President: Frank J. Smith. Vice-President: Edward H. Halbleib. Directors: F. F. Hickey, James E. Gleason, A. F. Sulzer, J. K. Baylis, Carl S. Hallauer, David W. Sowers, William Kelly. Secretary-Treasurer: Paul Folger, 1118 Mercantile Building, Rochester, N. Y.

Rocky Mountain Post, June 10, 1942.—President: Newell H. Orr. Vice-President: John G. Gates. Directors: A. T. Twing, C. O. Voigt, L. F. Quigg, James D. Maitland, Harold F. Silver. Secretary-Treasurer: James Colasanti, 601 Continental Oil Building, Denver, Colo.

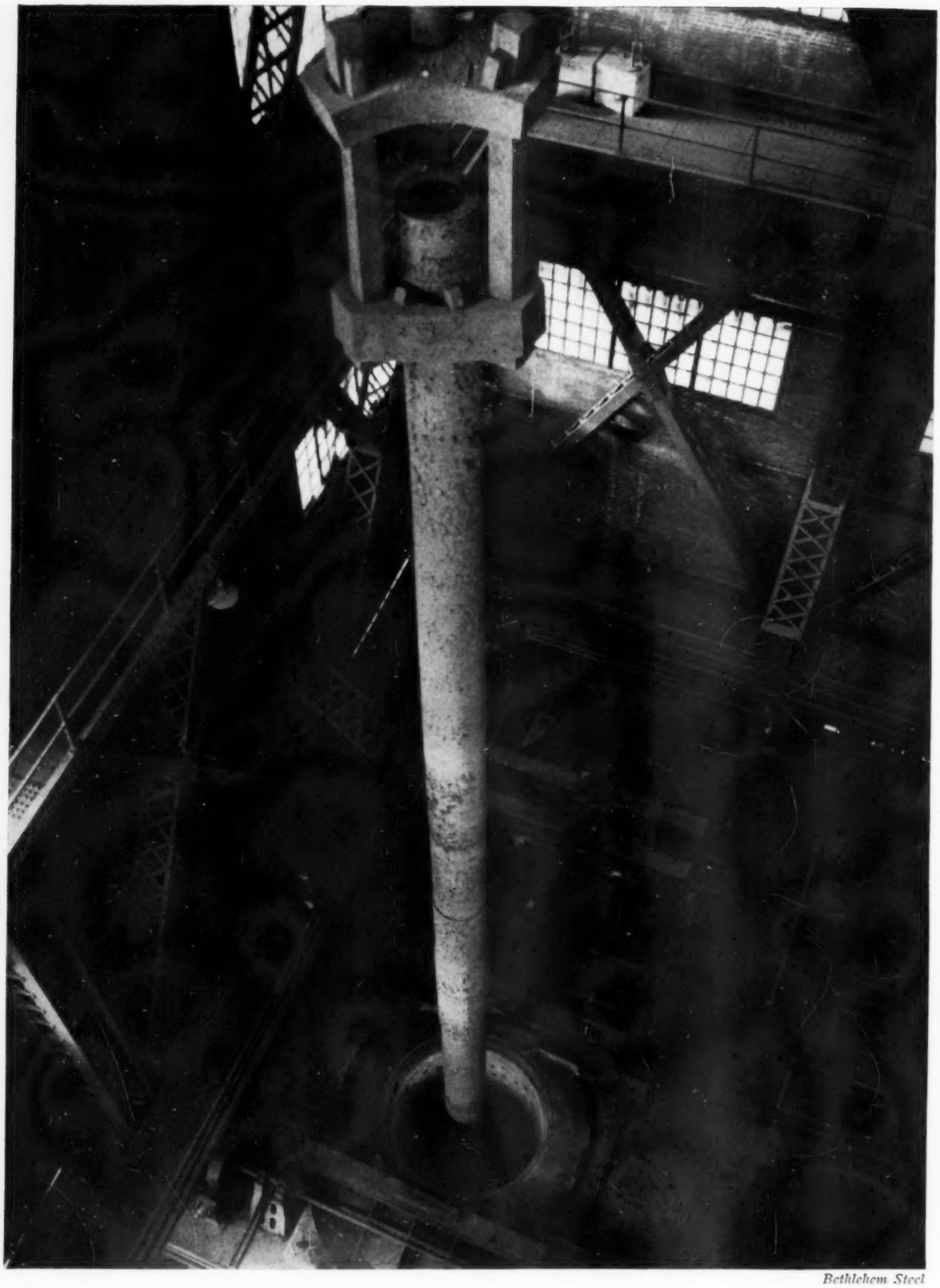
St. Louis, January 18, 1927.—President: Edwin B. Meissner. Vice-President: Robert A. Bagnell. Directors: Harry Scullin, Spencer Olin, P. J. Watson, Jr., Willard R. Cox, Ben Comfort, H. B. Deal, W. M. Akin, W. Stuart Symington. Secretary: Merle H. Davis, 3663 Lindell Boulevard, St. Louis, Mo.

San Francisco, October 17, 1923.—President: Roland L. Oliver. Vice-President: Leonard F. Fuller. Directors: D. C. Jackling, J. J. Thomas, Samuel Kahn, A. Leslie Oliver. Secretary-Treasurer: C. C. Harshman, 402 Hotel Empire, San Francisco, Calif.

Texas, October 30, 1942.—President: W. J. Gourley. Vice-President: B. T. McNeil. Directors: J. E. Rittersbacker, J. E. Mitchell, Jr., W. C. Trout, H. Sinclair, J. M. Kincaid, Jr., Colin McRae. Secretary-Treasurer: R. D. Campbell, 927 Liberty Bank Building, Dallas, Tex.

University of Michigan, February 20, 1941.—President: William Hutcherson. Vice-President: George Brundrett. Recording Secretary-Treasurer: James Carmichael. Corresponding Secretary: Charles M. Thatcher, 548 S. State Street, Ann Arbor, Mich.

Washington, November 18, 1925.—President: G. M. Barnes. Vice-Presidents: Henry P. Erwin, B. S. Mesick. Directors: Fred E. Wright, LeRoy Hodges, Fred. H. Wagner, Hardee Chambliss, S. E. Reimel, Paul Weeks, Philip Schwartz. Treasurer: Ralph I. Graves. Secretary: R. G. Van Ness, 705 Mills Building, Washington, D. C.



Bethlehem Steel

16-Inch Gun Tube

ARMY ORDNANCE

Volume XXIV JANUARY-FEBRUARY, 1943 No. 136

Communications in Global War

The Achievements of the Signal Corps in Modern Liaison

Maj. Gen. Dawson Olmstead*

THE speed of military movement and the far-flung theaters of operation of this global war have imposed upon the Signal Corps of the U. S. Army responsibilities far overshadowing those encountered at any other time in its eighty-two years of service to the country.

The Signal Corps pioneered in the use of visual signals and wire telegraphy during the Civil War; it carried on Arctic explorations and developed a national weather service in the latter part of the nineteenth century; it laid the first cable to Alaska; it conducted the Army's first experiments with airplanes; it established a major telephone network in France during the World War and repeatedly outwitted the Germans in the application of radio. But all these achievements of the past, inspiring though they are to our present personnel, have shrunk into insignificance when compared with the tremendous and variegated task now being accomplished for the Army by the Signal Corps.

The mission of the Signal Corps resolves itself into four major assignments. These are: (1) The supply of signal communication and other electrical equipment for the entire Army; (2) The training and equipment of troops for signal companies and battalions in the field; (3) The operation of the Army's communication network; (4) The photographic and motion-picture service of the Army.

In the function of supplying signal equipment to the entire Army, the Signal Corps has a task somewhat similar to that of the Ordnance Department with respect to tanks and guns and ammunition, except that the Signal Corps does not operate Government arsenals but procures entirely from privately owned facilities.

This service of signal supply is a multibillion-dollar undertaking. It requires the American radio manufacturing industry, for example, to produce more equipment for the Signal Corps alone than it did during peace-time years for all the nation's commercial needs. The necessary expansion has been particularly steep in the field of high-quality, precision-manufactured radio communication equipment.

It was only a few years ago that the 2-way short-wave radio in a municipal police car was considered a new and dramatic development in the field of communication. Today, every tank in the Armored Force, every mobile field-artillery unit, and thousands upon thousands of other combat vehicles must be equipped by the Signal Corps with 2-way radio communication. Every airplane of the Army Air Forces is a radio transmitting and receiving station, and many of the planes have two or more complete sets of radio equipment. In bombardment airplanes there are also the interphone systems by which the navigator, the pilot, the bombardier, and the other members of the crew can keep in constant communication despite the roar of engines and the separation of compartments.

It is the responsibility of the Signal Corps to supply radio transmitting and receiving sets that will operate with adequate range and reliability in the highest altitudes of airplane flight and other sets that will operate within a tank despite the hazards of shock and jar and despite the interference of the electrical ignition systems of an armored force. In addition to supplying the needs of the Air Forces as well as those of the Armored Force, the Signal Corps must see to it that each arm can maintain contact with the other. Things must be so arranged that the commander of a tank force on the ground and the leader of a squadron in the air can communicate with each other and coördinate their striking power.

THIS is one example among many that could be cited to illustrate one of the important tasks which the Signal Corps performs for the Army—coördination. There are many aspects of coördination. One aspect is coördinated application of communications in the field of battle; another is coordinated use of supply depots and repair shops; still another is coördinated application of manufacturing facilities on the home front.

Coördination of tactical communications requires planned allocation of frequencies in the radio spectrum, proper provision for range and mode of transmission, and preconceived and tested operating procedures by wire and radio. Coördination of repair facilities is furthered by reducing the number of different types of sets and increasing the proportion of interchangeable components. It is obvious that the greater the number of different sets in use, the more difficult will be the problems of training mechanics to service each one of them and of maintaining in divisional and army depots a sufficient stock of repair parts for each one.

For this reason, there has been a continual effort to replace obsolescent radio sets with a smaller number of new types which would satisfy each of the several purposes better than any one of the older specialized sets. In addition, where different types of complete equipment must be used, much progress has been made in assembling them from common components. This means a reduction in the number of different condensers, tubes, and other parts that must be kept in stock at depots; furthermore, this reduction of types also makes possible the expansion of mass production of the components in our factories.

This coördination of equipment and components has not been limited to the various branches of the Army. It has been extended also by continual coöperation between the Army and the Navy so that both services can replace vital communication-set components from a common reservoir.

*Chief Signal Officer, U. S. Army.

The instrument of this policy is the Army Communications and Equipment Coördination Board which has been set up in the Communications Coördination Division of the Office of the Chief Signal Officer. Upon this board are officers representing all the Army branches which use signal communication as well as representatives of the United States Navy and the armed forces of our allies. The board has considered and completed numerous cases since it was activated in November 1941. Each case has resulted either in the elimination of unnecessary types, the establishment of a standard, or the reconciliation of conflicting ideas into a procedure satisfactory to two or more branches.

COÖRDINATION recently has been improved in the actual production of communications equipment in the factory. In order to assist the radio and electrical industries in the problems incidental to their conversion to war production, the Signal Corps during the first half of 1942 assembled a highly valuable force of expediting engineers. These expediters visit factories which fall behind the high rate of production demanded of them. They ascertain the cause of difficulties. They help to procure strategic materials. They know the necessary channels for amending a priority rating if that amendment is warranted. They apply the successful experience of one plant to solving the problems of another.

Sometimes the expediters have unusual problems to surmount. For example, on one occasion a plant was unable to go into production on a vital item of Signal Corps procurement because the local public utility was prevented by state regulations from providing service to the factory as rapidly as was desired. The expediter prevailed upon the utility manager to institute service immediately. On another occasion, workers on high-precision parts were slowed up because they could not see well enough as a result of inadequate illumination of the factory premises. The Signal Corps expediter obtained quick delivery of a modern fluorescent lighting system.

Despite the demolition of such obstacles to production, it was found that there still remained many shortages which could be alleviated only by coöperative efforts of the procurement activities of the Army and the Navy. To this end, in August 1941 the expediting staff of the Signal Corps Procurement Division was combined with the corresponding group of the Navy Bureau of Ships into the Army-Navy Communications Production Expediting Agency. Both the Army and the Navy are fully represented in this agency. The chairman is a Signal Corps officer who reports to the director of the signal supply service in the Office of the Chief Signal Officer. The vice-chairman is a Navy officer who reports to the director of the radio and sound branch in the Bureau of Ships.

It is a function of the Army-Navy Communications Production Expediting Agency to see, where there is a limited quantity of material available in a state of partial manufacture, that the material shall be used for the purpose which is considered most urgent in our war plans, whether the completed equipment is intended for a branch of the Army, the Navy, or for one of the United Nations.

In this function, the Army-Navy Communications Production Agency acts with the advice and authority of the Army and Navy Munitions Board, the Joint Communications Board (representing the joint United States Chiefs of Staff) and the Combined Communications Board (representing the Combined Chiefs of Staff of the United Nations). The final authority in allocating signal equipment is the Munitions Assignments Board headed by Harry Hopkins. The Signal Corps is represented on appropriate subcommittees of this powerful board.

ONE of the prime considerations in allocating signal equipment is the raw-material situation. The Signal Corps has had to procure vast quantities of communications equipment despite the fact that some of the most basic raw materials are on the critical list. For example, let us consider the most common component of all communications equipment—insulated wire. Many miles of field wire for telephone and teletypewriter operation are consumed in establishing command circuits in any offensive operation. In addition, insulated wire of one sort or another is an essential component in wiring the radio, interphone, and fire-control systems in airplanes, ships, armored vehicles, and artillery installations. Yet the two materials that have been considered most basic to the fabrication of insulated wire are both critical materials—copper and rubber.

Copper is needed to conduct electricity. Rubber is needed as insulation to keep the electric current from straying from its appointed path. Everybody knows how scarce rubber has been since the Japanese worked their way down the Malay Peninsula; and copper, although mined in the United States, is also extremely critical because of its numerous important uses in war matériel.

Like the Ordnance Department, the Signal Corps has devoted every effort to minimize its requirements of copper and rubber. Our research laboratories have been active in applying synthetic materials as insulation in place of rubber, and careful studies have been made to reduce the amount of insulation to a minimum consistent with safety from short circuits. Copper continues to be used as the principal electrical conductor, but, in the design of field wire and cable, a distinction has been made between the function of electrical conductance and that of wire strength. Wire and cable have been assembled as composites of copper and steel or iron strands, the latter providing the necessary strength against breakage while a minimum amount of copper is used to provide the necessary electrical conductance.

These are but two of the most obvious problems in the supply of raw materials for signal communication equipment. There are other problems which I do not intend to discuss in this article. But I can say that all these difficulties are being surmounted. Our supply officers keep constantly before them the objective that no unit going into a theater of operation shall be lacking in the signal equipment which it needs to carry the offensive to the enemy.

A vital feature of the work of the Signal Corps is scientific research and engineering development. However, it is obviously impossible for me to go into details in a published article regarding the projects now under way behind the guarded doors of our laboratories. Some of these projects are concerned with the coördination and simplification and substitution which I have already discussed. Others are concerned with new equipment which I cannot discuss.

Within the limitations of secrecy, I may say that the Signal Corps has obtained a maximum of coöperation from private industry and independent research organizations, such as the laboratories of universities, in furthering the development of new equipment. In this connection, the National Defense Research Committee, headed by Dr. James Bryant Conant, the president of Harvard University, has been a most effective

Signal Corps

A MOBILE RADIO STATION WITH TRAILER-MOUNTED POWER UNIT OPERATED BY THE SIGNAL CORPS

means of liaison. This committee has assigned important projects to specially qualified scientists throughout the nation. The results of this fundamental research already have had an important influence in the design of equipment which is now in service in the Army and Navy.

Our research laboratories are manned by an alert force of civilian engineers, supervised by project officers of the Signal Corps. One of our most important laboratories is operated as a joint enterprise with the Army Air Forces Matériel Center, thus assuring the greatest degree of co-operation between the Signal Corps as a supply service and the Air Forces as a using arm. The same kind of coöperation is sought in the development of all types of signal equipment for the Ground Forces. The new developments in signal communication originated or processed by the various Signal Corps laboratories are invariably submitted for service tests and approval by the authorized board of the using arm.

THE Signal Corps is responsible in the field for the installation and operation of communications equipment down to and including the regimental echelon. It also operates lateral communications among adjacent units of the same echelon. Forward or assault units below the regimental echelon operate signal equipment with their own personnel, but divisional Signal Corps specialists are responsible for the issue and repair of this equipment.

To each division is attached a division signal company. Each corps includes a signal battalion. In addition, each field army is allotted a headquarters signal service company, a signal construction battalion, a signal operations battalion, a radio intelligence company, a signal depot company, a signal repair company, a signal pigeon company, and a signal photographic company. To supplement these Signal Corps units of the field army, the army commander can also call upon a G.H.Q. reserve, from which Signal troops of various categories may be drawn by the army requiring their services.

The organization and activation of such Signal Corps field units and the selection and training of men who constitute them is centrally directed by the Signal Operations Service in the Office of the Chief Signal Officer. The actual training is conducted in four major training centers devoted to the Signal Corps. Of these four, only one—Fort Monmouth—was in existence when the United States entered this war. Fort Monmouth, with its subposts, Camp Edison and Camp Wood, has extended over a large area comprising a number of communities in the general neighborhood of Red Bank, N. J. It may be regarded as the parent training center for the modern Signal Corps. However, the methods of training developed there are now used in other camps geographically dispersed throughout the nation. These are Camp Crowder in Missouri, Camp Kohler in California, and Camp Murphy in Florida.

The program of training advances in steps from the basic training of a soldier in military drill, rifle handling, etc., to highly specialized technical instruction in the maintenance of Signal Corps electrical equipment of great complexity.

The facilities of the Signal Corps training camps would permit an above-average selectee to go through the following sequence of steps: replacement training center for basic military and basic signal communication training; a specialty school in signal communication; enlisted men's department of a Signal Corps school for specialized training in either radio or wire communication; an officer-candidate preparatory school; an officer-candidate school; and, finally, the officers' department of a Signal Corps school. Thus the Signal Corps is now thoroughly equipped to take a soldier with natural aptitude and leadership qualities through all the necessary stages required to turn out a capable, resolute, and technically skilled officer to whom may be entrusted an important rôle in maintaining the communications of the Army. The Signal Corps can make good use of every man it trains this way, since the vast expansion of our Army, plus the great distances over which its strategic operations must be instantaneously coördinated, has thrown greatly enlarged responsibilities upon the agency which maintains the Army's communications.

In addition, the Signal Corps is responsible for the Aircraft Warning Service and its remarkable new devices for the non-aural detection of enemy craft. This is a field in which revolutionary changes have appeared, but, here again, it is not advisable to go into details because we do not want our enemies to discover—until the blow strikes them—just how far we have advanced. I only wish to point out that the extensive Signal Corps training program in the principles

and use of electricity and radio has applications which go considerably beyond what is usually considered to be the field of signal communication.

In addition to developing and procuring all types of communication and related electrical equipment, training men in their use, and organizing those men into companies and battalions for our divisions and field armies, the Signal Corps has another responsibility with respect to communication. It operates, directly from the War Department in Washington, the Army communication network. This is the organization which makes it possible for the Commander in Chief, the Chief of Staff, and the commanding generals of the three major divisions of the War Department to keep in almost constant touch with the developments in any one of the domestic commands and in any one of the theaters of operation overseas.

The heart of this network is the War Department Signal Center in the nation's Capital. By wire and radio, high-speed telegraphic messages move steadily in and out of this center, carrying a stream of vital orders and information. In its new home in the Pentagon Building in Arlington, Va., the signal center constitutes probably the world's most modern and efficient communications headquarters. Our engineers have utilized the best features of machine interconnection and streamlined message handling developed in the American commercial communication companies, which in themselves have led the world in this field.

The War Department Signal Center is, of course, only one unit of a network which reaches around the world by wire and radio. This network is outstanding in the speed with which words are transmitted and received. A great deal of the transmission is fully automatic; not only have we made complete use of the teletypewriter on wire circuits, but we have found that even more rapid transmission can be obtained with the radio-operated typewriters. In certain parts of the Army communication system, the principles of automatic business machines have been adapted to operation at a distance. We actually can do bookkeeping by wire and thus keep an automatic record in a central office of inventories and other accounting facts which have their physical reality at a remote warehouse or depot.

Each of the stations other than the signal center in the War Department is itself the control station of a smaller net. The Army radio station in any one of the service commands has a dual rôle. On the one hand, it is linked into the War Department radio net; on the other, it serves as control station for the communications network of its service command. The same is true, in a general way, of the key radio stations in our overseas theaters of operation.

All the activities of the Signal Corps which have been described so far in this article are concerned with signal communication—the transmission of information and commands across a distance, usually by electrical means. I now wish to discuss another kind of communication—the communication of accumulated knowledge and skills by means of pictures. This also is a function of the Signal Corps, which for years has been photographer to the Army. In our files in Washington are historic photographs of the Army's doings from the Civil War up to the present time. We are still making those photographs, both for intelligence purposes and for the information of the public through the press.

The motion-picture film has come to be recognized as one of the greatest training aids in our modern Army. Basic-training films produced under the supervision of the Signal Corps now have a regular place on the training schedule of troops in all the arms and services. These basic films portray the fundamental ideas of military courtesy, customs of the service, the articles of war, hygiene, and first aid. More advanced and specialized training films teach the Ordnance soldier the mechanism of the tank, the artillerist the principles behind the construction of shells and their propellants, the Signal Corps man the best way to splice his wire, and the Infantryman the assembly and disassembly of the rifle. Similar films show the airplane mechanic how to put together a variable-pitch propeller. Several hundred of these films already have been produced and distributed to film libraries of service commands and Army camps throughout the country. Many more are in production at the Signal Corps photographic center in Long Island City, N. Y., and at the training-film production laboratory which is operated for the benefit of the Air Forces at Wright Field, Ohio.

Not only have these films proved to be invaluable in training our own troops, but they also have served as a means of coöperation among the United Nations. Along with the weapons which are supplied to our allies, we are nowadays sending films to demonstrate their assembly and utilization. As rapidly as possible we are making transliterations of the sound tracks of our training films from English into various other languages.

An active program of film interchange has been developed with Canada and Great Britain—an interchange from which both sides benefit, since many British-made training films which show the experience of actual contact with the enemy have been procured for use in our own training program. The growth of the training-film program has been very rapid and has been manifested by the movement of the production center from a small building at Fort Monmouth to the huge photographic center which we now have in Long Island City.

To sum up, the Signal Corps exists primarily to serve the Army by providing the equipment of signal communication, the systematized and coördinated procedure for using it, the facilities for distributing and repairing it, and, in the case of the signal centers from the War Department down to the regimental echelon, the trained personnel to operate and maintain it.

The kind of war that is being waged in this fifth decade of the twentieth century has thrown an unprecedented burden on the military agencies of signal communication. When tanks cover more distance in an hour than was considered a respectable day's march in the premotor era and when planes traverse the globe at 300 to 400 miles an hour, orders and information must move at still greater speed.

There is only one thing on the ground that can outspeed the fastest motor vehicle, and that is the electrical circuit which carries messages by telephone, telegraph, and teletypewriter. There is only one thing which can speed through the air faster than a pursuit plane or a high-velocity shell, and that is the radio wave, which carries intelligence at the rate of 186,000 miles a second.

It is the function of those entrusted with the Army's signal communications to make use of these electrical media for the almost instantaneous transmission of intelligence so that the control of our tanks and planes and ships and missiles will be coördinated to insure victory. That is the task to which the Signal Corps is devoted.

The Ordnance Reorganization

Recent Changes Adapt the Department To Meet Its New Tasks

Col. J. C. Raaen*

MAJ. GEN. LEVIN H. CAMPBELL, JR., entered upon his tour of duty as Chief of Ordnance of the Army on June 1, 1942, when the Ordnance Department was well on the way in its stupendous task of developing and building superior modernized equipment for the largest coalition of armies ever assembled. His predecessor, Maj. Gen. C. M. Wesson, and his staff had carefully guided the Department from a peace-time status, with its small development program and meager manufacturing operations in Government proving grounds and arsenals with limited funds, to a war-time organization with research programs being carried forward in the leading scientific and engineering laboratories in the country and with supply contracts being placed through thirteen Ordnance district offices throughout the land.

This transition had taken place in strict accordance with the excellent Industrial Mobilization Plan conceived in the 'twenties and constantly kept current by the Ordnance Department and industrial leaders. This plan not only visualized the Ordnance Department, with its satellite district offices in a strategic rôle but included specific studies of all the factors to be used in estimating plant capacity and personnel for assignment to various tasks in time of war. Only through the careful execution of such a plan could the necessary peace-to-war transition have been made. Ordnance followed that plan when most other war-time agencies were groping for a way out. And Ordnance paid the nation dividends a thousandfold.

In the spring of 1942, when each week saw new fronts ablaze—with resultant changes in raw materials and labor conditions—it became apparent that some adjustments would have to be made in the previously conceived form of departmental organization.

General Campbell assumed direction of an organization newly moved to quarters in the partially completed Pentagon Building in Arlington, Va., across the Potomac from Washington. At that time, ordnance matériel contracted for already exceeded twice the total of ordnance production in the first World War. Dollar for dollar, too, this fighting equipment was more complicated, demanded closer tolerances, and covered an almost infinitely wider range of items. Not only were great quantities of matériel obtained for our troops, but a tremendous portion of the goods manufactured were for Lend-Lease assistance to our ever-increasing and overburdened allies. The supply of matériel through Lend-Lease, though a heavy burden not fully covered by earlier procurement plans, in addition to assisting our present allies gave the Ordnance Department an opportunity to mobilize industry further and permitted actual combat testing of Ordnance-designed equipment before full production was under way for our own troops.

In June 1942, more industrial concerns were manufacturing ordnance matériel than ever before. Threatened raw-material shortages required alternative Ordnance designs. Fighting equipment was being used in all types of extreme climates, either by our allies or our own troops, thus further complicating the engineering problems and making necessary the planning of an unprecedented supply and maintenance force.

At that time, the scope of the war to be fought by the armed forces of this country and the extent of the vast quantities of supplies that this nation's industry must produce were becoming apparent. Mobilization of industry to the point where available labor and raw materials could be utilized was practically completed and contract adjustments to reflect the actual needs were being made. It was considered timely, then, that the Ordnance Department organizational set-up to cover the transition period from peace to war should be studied with a view to adapting it more nearly to meet the demands placed upon it by the type of war then taking shape.

General Campbell's experience in the Ordnance Department had developed acquaintanceship with many industrial and educational leaders. Upon induction as Chief of Ordnance, he quickly called several of these leaders to work as an advisory staff to aid him in determining what changes could be made in the organization of the Ordnance Department so as to further the already excellent coöperation with the numerous industrial concerns engaged in the production of ordnance matériel. One of the first and most interesting features already begun by General Campbell was that group of organizations known as the "Industry Integration Committees" (see article on p. 72 of this issue).

IN the operation of these committees, ordnance matériel is grouped into classes having similar production problems. Representatives of concerns engaged in the manufacture of these similar items meet periodically, usually at one of the plants, and discuss with interested Ordnance officers the problems currently facing the production men. Opportunities are provided by contractors for inspection of each other's plants. Ideas on new production problems are fully utilized. When available, raw materials and component parts are exchanged between manufacturers so as to eliminate the necessity for shutdowns in some plants while others carry stocks of raw materials. Suggested design changes to facilitate production are discussed and, where feasible, are quickly adopted. Committee meetings are carried out on an informal basis and are held only when deemed necessary to furnish solutions to pressing problems.

In considering organizational changes required to meet new tasks, General Campbell recognized the importance of research and development by greatly increasing the engineering design activities of the Ordnance Department in a new Technical Division. This division is on the same level of command as production and field service, with Brig. Gen. G. M. Barnes as chief. General Barnes has long experience in problems of designing ordnance matériel and adapting it for mass production. His influence on armament research followed his chief's steps, and he established an advisory council composed of prominent research men and industrial-

*Executive Officer, Office of the Chief of Ordnance. Colonel, Ordnance Department, U. S. Army.

ists capable of keeping him informed on the latest developments and of evaluating the ideas brought forth by other Ordnance engineers.

EACH new model developed by the Technical Division and produced by the industries, though a necessary aid to combat troops, tended to increase the maintenance problems of Ordnance soldiers already overburdened by the opening of many new battle fronts. General Staff plans, which recognized the Ordnance Department as composed of 350 officers in 1939, contemplated requirements for 19,000 trained Ordnance officers in the spring of 1943. In three years, the demand was set up for more officers than there were total Ordnance troops in the Ordnance Department at the beginning of that period. Accordingly, Brig. Gen. Julian S. Hatcher, an officer who had organized Ordnance training schools in the last war and who had been commandant of the Ordnance School at Aberdeen Proving Ground since the establishment of the Ordnance Training Center there in the spring of 1941, was instructed to set up the Military Training Division on the same level as the Technical, Industrial, and Field Service Divisions. Calling in leading educators as an advisory faculty, General Hatcher set about to improve and expand the series of Ordnance replacement centers and various Ordnance training schools throughout the country.

Shortly after the establishment of the Military Training and Technical Divisions, the Ordnance Department was assigned the task of administering the activities pertaining to the design, procurement, production, and maintenance of all transport vehicles, formerly a function of the Motor Transport Service of the Quartermaster Corps. This consolidation meant that the Ordnance Department was charged with design, procurement, issue, and maintenance of all self-propelled vehicles, except for a very few single-purpose items. Motor-transport procurement policies had to be adapted to those policies established and in use by the Ordnance Department. Many field depots had to be absorbed as well as schools for the training of transport-maintenance specialists and technicians. This involved the transfer of approximately a thousand office personnel alone, increasing Ordnance personnel in Washington by approximately twenty per cent.

Prior to the merger of the Motor Transport Service with Ordnance, tank production had played a major part in utilizing the manufacturing capacity and production "know-how" of the Detroit automobile industries. General Campbell felt that considerable time-wasting red tape could be eliminated by moving that portion of the Office of the Chief of Ordnance dealing with tank production to Detroit. The acquisition of the Motor Transport Service made the desirability of such a move obvious, and in August 1942 it was announced that the Tank-Automotive Center was to be established in Detroit as a unit of the Office of the Chief of Ordnance, to operate independently of the Detroit Ordnance District and to deal with all matters pertaining to Ordnance automotive-vehicle production as though it were located in Washington.

The move to Detroit was only one step in the decentralization of Ordnance activities taken by General Campbell. Several similar moves were made in the Department at the same time. The Safety and Security Branch—the staff branch under Col. Francis H. Miles, Jr., responsible for taking steps to insure the safety and security of Ordnance- and contractor-owned field establishments handling ammunition, explosives, propellants, or ingredients thereof—was moved to Chicago. This furnished a more central location for the dissemination of safety instructions and a more convenient base from which inspectors might operate in plants located throughout the country. Similarly, the field director of ammunition plants—Col. T. C. Gerber—established an office in St. Louis, Mo. A large portion of the activities in connection with the procurement and testing of gages was moved out of Washington to quarters in Philadelphia convenient to Frankford Arsenal and eastern toolmakers. Activities in connection with small-arms procurement and antiaircraft-artillery maintenance also were moved to Philadelphia. Decentralization of other units was ordered, and more are scheduled.

TANK-AUTOMOTIVE CENTER: Union Guardian Building, Detroit, Mich. Brig. Gen. A. R. Glancy, Deputy Chief of Ordnance; Brig. Gen. Donald Armstrong, chief; Brig. Gen. John K. Christmas, assistant chief.

SAFETY AND SECURITY BRANCH: 333 N. Michigan Ave., Chicago, Ill. Col. Francis H. Miles, Jr., chief.

FIELD DIRECTOR OF AMMUNITION PLANTS—Ammunition Branch, Industrial Division: 3637 Lindell Blvd., St. Louis, Mo. Col. T. C. Gerber, field director.

SMALL ARMS AMMUNITION SUBOFFICE—Small Arms Branch, Industrial Division: N. W. Ayer Building, West Washington Square, Philadelphia, Pa. Col. Boone Gross, officer in charge.

INSPECTION GAGE SUBOFFICE—Production Service Branch, Industrial Division: 238 East Wyoming Ave., Philadelphia, Pa. Lieut. Col. D. A. Lenk, officer in charge.

FIRE CONTROL AND ANTIAIRCRAFT UNIT—Maintenance Branch, Field Service Division: Frankford Arsenal, Philadelphia, Pa. Maj. John A. Plimpon, officer in charge.

PHILADELPHIA AMMUNITION SUPPLY OFFICE—Ammunition Supply Branch, Field Service Division: 904 Chestnut St., Philadelphia, Pa. Maj. H. G. Hamilton, officer in charge.

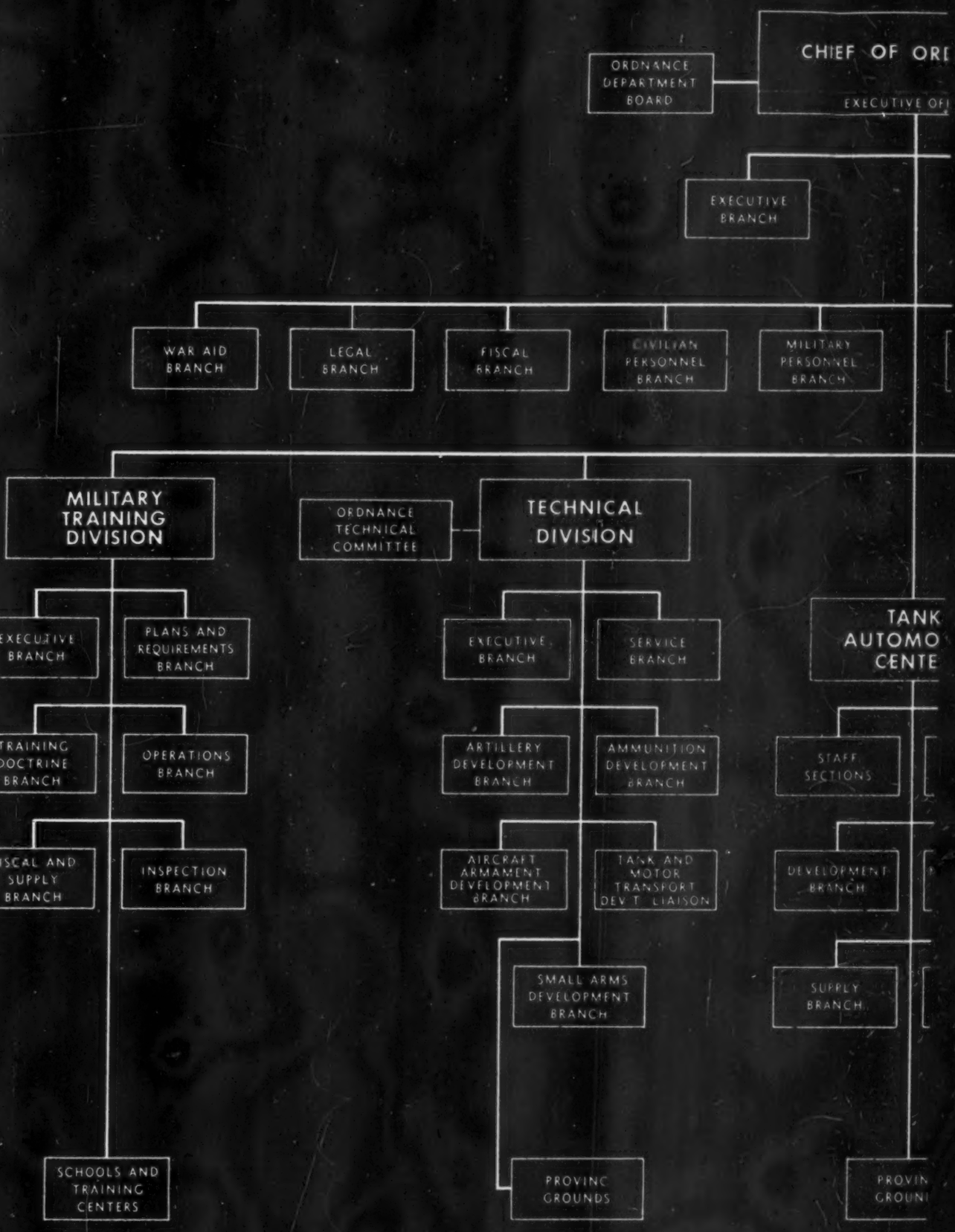
FIELD OFFICE, SHOPS AND EQUIPMENT SECTION—Maintenance Branch, Field Service Division: Philadelphia Mobile Shop Depot, 34th and Curie Sts., Philadelphia, Pa.

LOCATION OF THE DECENTRALIZED PARTS OF THE OFFICE OF THE CHIEF OF ORDNANCE

On June 26, 1942, General Campbell authorized the publication of Ordnance Department Order No. 285 which established the Technical and Military Training Divisions and outlined the new organization of the Ordnance Department. Changes to this order have subsequently been published authorizing organizational adjustments so as to maintain working procedures best adapted to conditions at hand. The latest organization chart authorized by Order No. 285 is shown opposite facing this page. It presents the organization as composed of four divisions, the Tank-Automotive Center, and a group of staff branches. Following are descriptions of the activities performed by each of these parts of the organization:

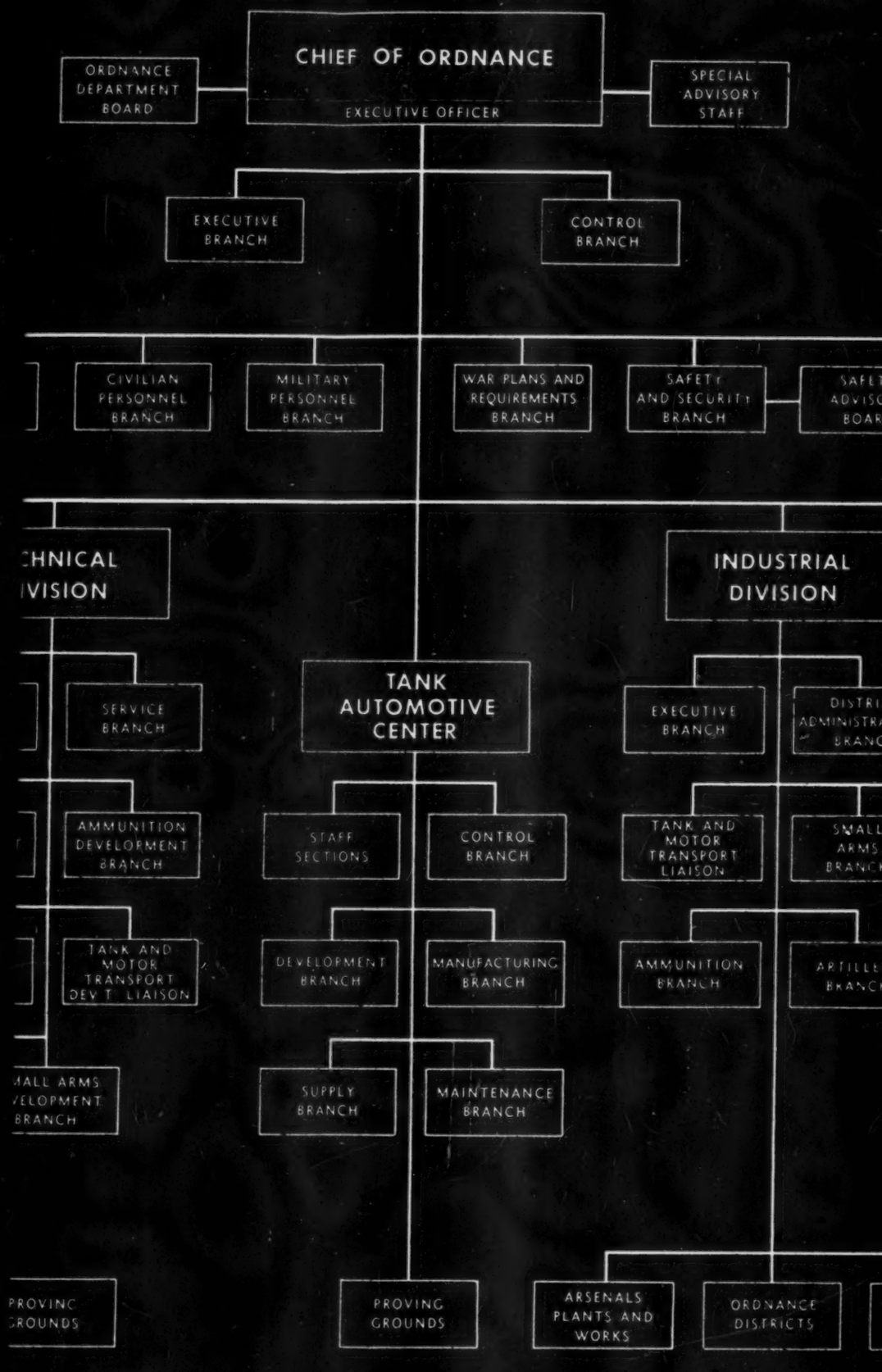
INDUSTRIAL DIVISION (Maj. Gen. Thomas J. Hayes, chief).—"The Industrial Division will procure, produce, inspect, and accept all Ordnance matériel and spare parts therefor, and perform the related engineering work; will provide for the construction of new manufacturing plants and the conversion and expansion of existing plants needed for procurement; and will perform all duties incident to procurement not otherwise specifically assigned, including authorized duties in connection with assigned field establishments, and the maintenance of close coöperation with industry."

ORGANIZATION OF THE ORDNAN

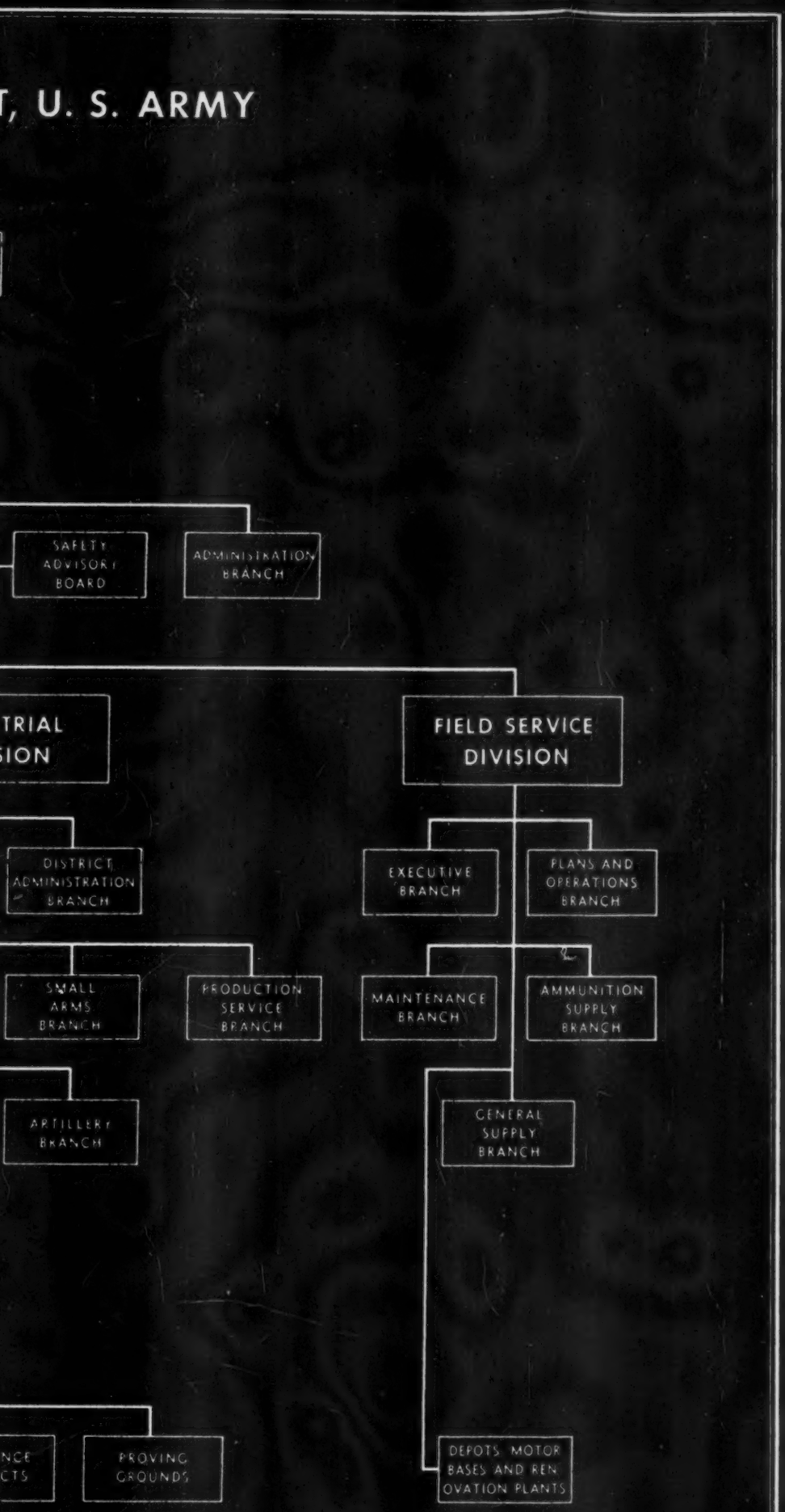


10/27/42

TION OF THE ORDNANCE DEPARTMENT, U. S



T, U. S. ARMY


SAFETY ADVISORY BOARD
ADMINISTRATION BRANCH
TRIAL SION
FIELD SERVICE DIVISION
DISTRICT ADMINISTRATION BRANCH
EXECUTIVE BRANCH
PLANS AND OPERATIONS BRANCH
SMALL ARMS BRANCH
PRODUCTION SERVICE BRANCH
MAINTENANCE BRANCH
AMMUNITION SUPPLY BRANCH
ARTILLERY BRANCH
GENERAL SUPPLY BRANCH
NCE CTS
PROVING GROUNDS
DEPOTS MOTOR BASES AND REN OVATION PLANTS

It is in this division that the designs of ordnance matériel approved for manufacture and funds made available to the Ordnance Department are brought together, and procurement is initiated with industrial concerns through the Ordnance districts, or production orders are placed with the manufacturing arsenals. Although procurement requisitions are prepared and forwarded from Washington, the thirteen district offices perform the actual contract negotiations. Decentralization is seen here again to the extent that single contracts involving sums up to $5,000,000 can be placed in the districts without specific approval from Washington.

The Industrial Division sends designs and specifications to the Ordnance district offices where engineering advice is available to contractors. In addition, help is obtained from the Industry Integration Committees, discussed earlier, and used for spreading production "know-how." Inspection work is carried on in the districts by approximately 20,000 inspectors stationed in the plants of prime and subcontractors.

As in the case of the Technical Division, branches have been established to each of which are assigned the procurement of specific groups of matériel. Although the District Administration Branch is responsible for the administration of the district offices, each of the matériel branches deals directly with the procurement officers in the district offices when advising of items to be procured, submitting drawings and specifications, and supervising the operation of the Industry Integration Committees. When cases come up requiring the coördination of activities between two or more matériel branches, the Production Service Branch assists by performing liaison functions. This branch is also active in matters of plant conversion, raw-materials and machine-tool allocations, gage and machine-tool procurement, transportation, and storage prior to transfer to the Field Service Division.

MILITARY TRAINING DIVISION (Brig. Gen. Julian S. Hatcher, chief).—"The Military Training Division will be responsible for training of Ordnance military personnel, including promulgation of training doctrines, scheduling of training programs, conducting and supervising training, and for assignment, selection, and relief of training personnel."

Charged with the responsibility of operating all the Ordnance schools and Ordnance replacement training centers, the Military Training Division centers its greatest activity at the replacement training center and training schools at Aberdeen Proving Ground. There, new training doctrines are introduced and new teaching techniques are worked out. The use of moving pictures and other visual aids is widespread, and textbooks make interesting and effective reading by the use of amusing, yet pointed, graphic presentations. Junior officers, themselves recently graduated from officer-candidate schools, act as instructors. At one time, serious consideration was given to the utilization of instructors from various colleges and universities throughout the country. Such men who arrived for interview, however, after watching Ordnance officers present their material refused even to consider positions, explaining that they feared to attempt to live up to the standards of quality and speed of instruction set by these young officers.

Students of these schools are obtained as recruits from various induction centers. After appropriate periods of training, they emerge as trained replacements for specialists, technicians, or cadres. Second lieutenants are also graduated from the officer-candidate school, and special refresher and advanced-training courses are available for officers of all grades. Training under the jurisdiction of this division continues on a unit basis until assignment is made to a combat outfit, at which time training is no longer an Ordnance responsibility. Individuals may return to schools for supplementary training at any time.

TECHNICAL DIVISION (Brig. Gen. G. M. Barnes, chief).—"The Technical Division will carry out forward-looking programs of research and development of new and improved ordnance matériel and of new and improved materials for Ordnance use."

Perhaps the most important single group of persons connected with the Technical Division is the Ordnance Technical Committee, established by Army Regulations many years ago and composed of representatives of all the arms using ordnance matériel. This group considers and approves for production fighting equipment being developed for issue to the armed forces.

Actual development work is carried on by five branches, each handling a specific type of matériel. Each branch recommends to the chief of the division design and performance characteristics of ordnance matériel as well as improvements to existing equipment. It coördinates and controls the execution of development projects, investigates reports of defective functioning of standard Ordnance items, and works out changes required to eliminate such difficulties.

Of particular interest is the Service Branch which administers the preparation and clearance of specifications for ordnance matériel; supervises the preparation of firing tables, bombing tables, ballistic computations; constantly scans civilian research for usable ideas; works closely with the Inventors Council and, through design changes, promotes substitution of available for strategic materials.

FIELD SERVICE DIVISION (Brig. Gen. Harry R. Kutz, chief).—"The Field Service Division will store and issue ordnance matériel; will inspect, repair, alter, and maintain ordnance matériel in the hands of troops and in storage; will formulate spare-parts policies and, upon their approval by the Chief of Ordnance, will be responsible for their execution; will control the supply of spare parts so as to insure ready availability in sufficient quantity where and when required; will issue requisitions on the Industrial Division for parts procurement; will prepare and review technical manuals and review training manuals and perform authorized duties in connection with assigned field establishments."

The Field Service Division has made great progress in performing a major function of the Ordnance Department—actual issue and maintenance of matériel in the field. For some time this division operated on a scale not commensurate with the procurement activities of the Ordnance Department due to the fact that large quantities of matériel were not yet available for issue and maintenance. However, during the past five months steps have been taken to make this as strong as any division of the Ordnance Department. Although in the early spring it was clearly seen what quantities of supplies would be required, the actual disposition of those supplies and the maintenance problems involved had not yet fully taken shape.

Many officers in the Ordnance Department had had wide industrial experience and, accordingly, a massive procurement program was not completely new to them. Few officers were available, however, with experience in the operation of supply and maintenance organizations in combat areas. It is

apparent that men required to staff such organizations must be able to revise operations quickly and to make instant decisions upon the accuracy of which depend the lives of many men. A large number of the experienced Regular Army officers who did the planning for the initial procurement program and industrial conversion have been transferred to the Field Service Division or its field establishments and to the battle fronts to fill the personnel requirements of this division.

The Field Service Division receives matériel as released by the Industrial Division and stores it preparatory to issue. The Executive Branch reviews recommendations for assignment of Ordnance units, compiles the Ordnance section of tables of organization, adjusts basic-allowance tables for ordnance matériel, and supervises salvage and scrapping of such matériel.

When orders are issued by the General Staff for the activation of troop units, such orders filter through the War Plans and Requirements Branch (Ordnance staff branch), and the Ammunition and General Supply Branches of the Field Service Division are authorized to issue a list of matériel to the activated units. These branches then issue the authorized equipment or, if not available, authorized substitutes therefor. The issue of matériel to overseas depots and units is also made by these branches as authorized by higher authority. Planning activities are coördinated by the Plans and Operations Branch which also controls space for storage and originates plans, drawings, specifications, and estimates for the general activities of Field Service establishments.

Tank-Automotive Center (Brig. Gen. A. R. Glancy, Deputy Chief of Ordnance; Brig. Gen. Donald Armstrong, chief).—"The Tank-Automotive Center constitutes the operating portion of the Office of the Chief of Ordnance concerned with the development, design, manufacture, storage, supply, and maintenance of tanks, self-propelled mounts, motor combat and transport vehicles. The division chiefs will issue instructions to the Deputy Chief of Ordnance (Tank-Automotive Center) as to matters that come within their stated responsibilities. . . . The Deputy Chief of Ordnance, as the special representative of the Chief of Ordnance and the division chiefs in Detroit, will maintain close cooperation with industry, administer the Tank-Automotive Center, supervise and direct activities of the various subdivisions of the Center, and perform such other related duties as may be assigned by the Chief of Ordnance."

The establishment of the Tank-Automotive Center under the leadership of the Deputy Chief of Ordnance, General Glancy, former president of Pontiac Motors, was the greatest step taken toward decentralization since the Ordnance district offices were established during the last war. General Campbell has specifically stated that in the operation of this office the Center should be considered as though it were located in Washington at an address on "Detroit Avenue."

The establishment of the Tank-Automotive Center was brought about by moving the personnel from the Tank and Motor Transport Branches of the Technical, Industrial, and Field Service Divisions to Detroit. With the exception of the omission of a counterpart of the Military Training Division, the organization set up in Detroit is roughly parallel to the organization of the Office of the Chief of Ordnance in Washington. Liaison is maintained in the chief's office so that unity with the Washington organization may be maintained. The relationship between the Detroit Ordnance District and the Tank-Automotive Center is the same as that existing between any Ordnance district and other portions of the Office of the Chief of Ordnance.

Staff Branches.—Staff branches operate under the direction of the executive officer, Col. J. C. Raaen. The staff branches can be described as general housekeeping units performing for all the divisions those activities described by their titles.

Officers in the *Executive Branch* are assigned to investigate and study such special problems as may be directed by General Campbell and are responsible for interdivisional coordination.

The *Control Branch* (Col. C. E. Davies, chief) is charged with the responsibility of supervising the preparation of statistics showing the progress of procurement and other Ordnance activities. It also makes recommendations to General Campbell on organizational changes required to adapt Ordnance procedure to changing conditions.

The *War Aid Branch* (Lieut. Col. Paul Seleen, chief) acts as a focal point for clearance of Lend-Lease requisitions and special problems in order to expedite the procurement and shipment of matériel to our allies. Operating functions are performed by the branch only to the extent of transmitting requisitions to the Industrial and Field Service Divisions where activities merge with duties performed for procurement, storage, and shipment of United States matériel.

The *Legal Branch* (Col. Irving A. Duffy, chief), *Fiscal Branch* (Col. James D. McIntyre, chief), *Civilian Personnel Branch* (Lieut. Col. W. C. Pew, chief), and *Military Personnel Branch* (Col. C. Wingate Reed, chief) operate as their names imply, acting as central points for those necessary services required by all the divisions.

The *War Plans and Requirements Branch* (Col. B. R. Olmsted, chief) computes matériel requirements as indicated by troop bases promulgated by higher authority. The Ordnance portion of the Army supply program is prepared in this office, and tables of basic allowances showing Ordnance requirements for all troop units are kept up to date.

The *Safety and Security Branch* (Col. F. H. Miles, Jr., chief), aided by the Safety Advisory Board, has already been discussed in connection with its operations from Chicago.

The *Administration Branch* (Lieut. Col. L. G. Schmidt, chief) performs the necessary activities of supplying space, telephones, office equipment, mail and file services, etc., for the Office of the Chief of Ordnance.

The above description of the Ordnance Department organization shows adjustments that already have been made in order to meet the constantly changing demands brought about by this war. Conflicting criticisms have been leveled at the Ordnance Department to the effect that (1) through unwillingness to change, the organization does not reflect current problems, and that (2) the organization changes so rapidly in form that it is difficult for business men to know with whom to discuss specific problems. Information presented herein tends to show that neither of these viewpoints is justified.

At the present time, it is felt that the major changes required to adapt the Ordnance Department organization to meet the demands of global war now have been made. As conditions continue to change, new problems arise, and old ones are overcome, readjustments will be made within the organization to minimize red tape and maximize the number of officers available for field duty while at the same time producing the greatest amount of superior equipment possible.

Cavalry Journal

Our Tanks Meet the Test

American Plans and Equipment Are Vindicated in the Middle East

Maj. Gen. C. L. Scott *

IN my opinion there has been entirely too much nonconstructive, ill-informed, and ill-advised criticism on the subject of military equipment. The War Department and our services have been accused of failure to visualize modern warfare, to plan constructively well in advance, and to produce suitable items of modern equipment. To make such statements when they are not fully true, and to give the impression that our equipment is inferior to that of an enemy—as has been done in the case of planes, tanks, and guns—destroys the confidence of the soldier in his weapons and the confidence of the manufacturer, worker, and the public in our arms-production program. Such critics had far better devote their time and energy in helping to produce approved equipment promptly and in conserving the raw material needed in its production. When we do this, the killing and the destruction of the enemy will replace nonconstructive chatter.

To illustrate my point in the above paragraph, I cite an editorial appearing in one of our leading magazines in August 1942, where the author presents *his ideas* in detail as to the shortcomings of our tanks as evidenced in the last Libyan campaign. Strangely enough, he picks out for criticism the rubber treads on our tanks and comments as follows:

"But to make matters still worse, the right-hand tread on the tank (made curiously and uniquely of rubber composition) quickly got worn to tatters as the result of constant gun recoil," of the 75-mm. gun placed in the right sponson. Also, in the discussion of our new M4, he states, "The tread is still composed of rubber composition, as contrasted with steel for the British and German tanks."

Now certainly both of these statements would lead the ordinary reader to believe that some one had made a terrible mistake in design when we made use of the rubber track instead of a steel track. The facts of the case are as follows:

1. The rubber tread was developed after years of careful study and experimentation by the rubber industry and the Ordnance Department, because the use of rubber of proper composition promised to provide our tanks with the best tread in the world.

2. In all work, including that in the Libyan desert, our rubber-composition treads give 2½ to 3 times the mileage that is obtained by either British or German steel treads.

3. Our tanks with rubber treads can be marched over roads without cutting them up and rapidly destroying them, as is the case with steel tracks—a highly important military factor.

4. There is a great deal less vibration in motion from a rubber track, as compared with a steel track; consequently the rubber tread does not tire or fray the nerves of tank crews nearly as much as does the steel tread.

With regard to the wear and tear on the rubber tread from gun recoil, in my 4-month observation of our tanks in Libya I neither saw nor heard of any consequential wear of this nature. In fact, all I heard was praise of the tread for its long mileage and other favorable characteristics. Even if wear had occurred from gun recoil on one side as stated, it would have been a very, very simple matter to change the right and left tracks and thus equalize the wear. There are other equally pointless and misleading statements in this article, but again the point I wish to make is: Where do such nonconstructive criticisms lead us? What useful purpose do they serve?

Of one thing you may be certain and that is that we have

*Commanding the Armored Force Replacement Training Center, Fort Knox, Ky.

A British Crew Loads Ammunition aboard an American M3 Tank in the Libyan Desert

far more competent observers in the Middle East from both the Ordnance Department and the using arms than has any magazine. You may also be certain that we know all defects in all our items of equipment from these sources and directly from British personnel and that we initiated steps to eliminate such defects long before they could be brought to the attention of the public in even a correctly informed article.

BEFORE taking up some details of my observation on the performance of American equipment during active operations, I wish to quote parts of a speech that I made to the Society of Automotive Engineers in January 1941 which was reprinted in the May-June 1941 issue of Army Ordnance (Vol. XXI, No. 126, p. 603). These quotations are used to show that modern warfare *had been visualized correctly* and that production of equipment had been well planned by the using branch, the Ordnance Department, and industry before we even knew for sure that we would be in this war up to our necks:

"We are living in a machine age—an oft-repeated fact, but of the greatest military significance. As a result, one sees all the major powers of the world in this period of emergency striving desperately to utilize all types of equipment to produce the additional machinery and armaments needed in modern warfare. Among the new means required for battle may be mentioned airplanes of many types; motor vehicles; light, medium, and heavy tanks; antiaircraft and antitank weapons.

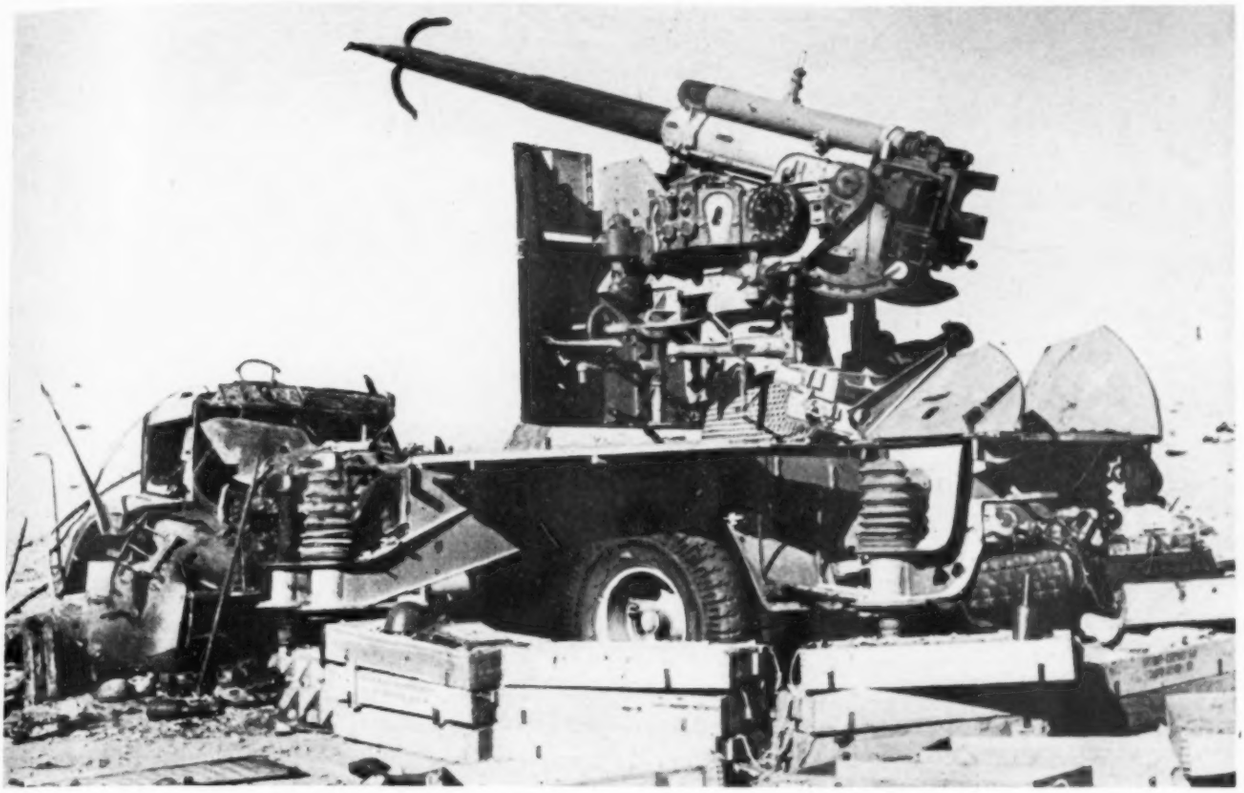
"The introduction of this machinery and new units into an army requires careful study, intensive training, and new methods of operation to secure the necessary teamwork between the new elements of our Army and the old arms which have withstood the test of past battles. Aviation, armored units, motorized units, and other normal units are all playing an important part in battles of today. The greatest success is being attained only when each arm is utilized to fill its prescribed rôle as a member of the national combat team.

"In the development of our present tanks, the Chiefs of Cavalry and Infantry (who had this duty prior to the creation of the Armored Force), the Chief of the Armored Force, and the Ordnance Department very wisely insisted on securing a tank which had great speed, power, cruising radius, and crew space for not less than four men. The value of speed, power, and cruising radius has been fully demonstrated in recent campaigns in Europe where fast tanks have outmaneuvered slow ones and where distances up to 1,100 miles have been covered in 5 days by armored units.

"In substance, it is believed that the Ordnance Department has produced for us one of the finest multiple-place tank chassis in the world, but we still are faced with the problem of improving the inside of the tank, its turret, and its armament in order to make it the finest of fighting vehicles. Fortunately, many of the necessary changes can be made, and are under way, without slowing production—which is of particular importance now.

"Among tank developments of paramount importance are: improvement in cold-weather starting, power traverse for turrets, relocation of cannon in turret, periscopic sight, indirect-vision devices, adequate padding for crew—all these have been under consideration for years and solutions are in sight for most of them.

"Also, while it is now necessary to freeze designs in order to attain the maximum speed of production, we must look to the future and produce new models if we are to be assured of maintaining a superiority in equipment over a likely



A DAMAGED GERMAN 88-MM. GUN ON TRUCK MOUNT CAPTURED NEAR EL ALAMEIN

enemy. The requirement of new models for tanks will closely parallel those of the Air Corps for planes in that the demand will be for more speed, more power, larger crews, more armor, and better armament.

"With the continuation of the close spirit of coöperation that exists between the Armored Force, the Ordnance Department, and our automotive industries, all present and future problems of production unquestionably can be solved. The importance of producing up-to-date equipment, in maintaining a superiority over a likely enemy in this respect, and of the peace-time training of units cannot be overstressed. Frederick the Great said: 'In my opinion, we owe the happy results of our battles and campaigns much rather to our work in time of peace than to the brilliant inspirations of some genius.' "

At the time the above-mentioned article was prepared, the War Department, the Armored Force and other using arms, the Ordnance Department, and manufacturers had agreed upon the freezing and going into quantity production of all the items of equipment whose performance I witnessed in the desert, such as our light M3 tank, our medium M3 tank, motor vehicles, and other weapons. At the same time it was unanimously agreed, although we thought we were on a par with a likely enemy, to go ahead with plans for all improvements mentioned in the above quotation and for still better items of equipment. In short, we were making extremely sound plans in peace time for the battles and campaigns that we could foresee in the future.

I was stationed as senior military observer for the United States in the Middle East from March 1942 until July. The directions for my work in this active theater were to obtain first-hand information on the performance in battle of a number of items of American equipment, to study the organization, training, tactics, technique, and logistics of the British Army and also, as far as possible, of Rommel's army. During my stay in the Middle East I received the utmost assistance and consideration from the commander in chief of the British forces.

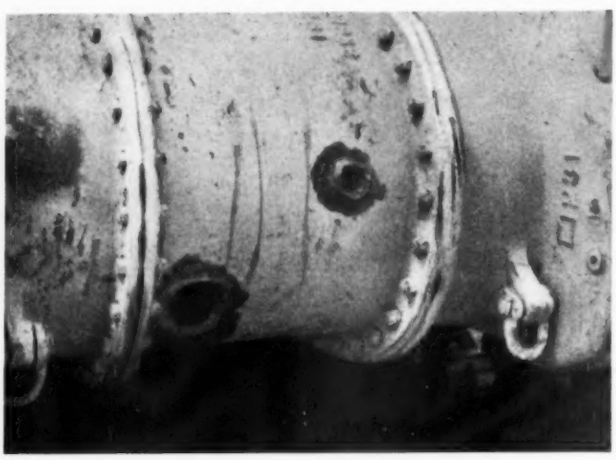
AS to equipment, our rifles, machine guns, artillery, trucks, peeps, jeeps, scout cars, armored cars, light and medium tanks, combat planes—*all* are giving splendid service there in the desert. After witnessing these active operations, in my opinion and in the opinion of the great majority of British personnel using it in battle, this American equipment, item for item, is at least equal and in many cases superior to both German and Italian equipment. The performance of our tanks was especially gratifying. Our light tank, which the British call the General Stuart, is the fastest, best armored, and most reliable vehicle in its class. Our medium M3 tank, which the British call the General Grant, has better armor than, and its 75-mm. cannon outranges the German Mark IV tank. These two things are the most important military characteristics demanded of this fighting vehicle. Of course, this tank would be still better were its gun placed in the turret instead of in the sponson and if it had more speed and power. These changes are being made, in addition to other improvements, in our new M4 medium tanks now in quantity production. The M4 tank and our present light tank, we can safely say, outmatch anything that the Germans now have in these classes. Don't forget that the General Stuart and General Grant were designed years prior to these observations.

The fact that the German 88-mm. gun did knock out many tanks caused unjustified criticism of both the British and American vehicles; therefore, it is well to discuss briefly the

principle involved in the use of this weapon and methods to combat it. The German 88-mm. gun is simply a large-caliber, high-velocity, combination antiaircraft-antitank gun which will knock out, at ranges up to 3,000 yards, any light or medium tank which we, the British, the Germans, or the Japanese can produce. It is the same old story of gun superiority over armor. However, this weapon, after all, is merely an artillery piece and can be neutralized and destroyed by counterbattery fire and by machine-gun, infantry, and air attacks. To fight it with these means and not with tanks is simply sound tactics. The British had no antitank gun in the Middle East to match the German 88-mm. It is revealing no military secret to tell you that we have and are producing weapons which will not only match, but which will *outmatch,* Rommel's prize gun.

A Hit on the Sponson of an M3 Tank by a German Mark IV Which Failed To Penetrate

As clearly indicated in the above quotations, the War Department, the Services of Supply, our Armored Force, and our manufacturers clearly realize the importance of the production of equipment equal and, if possible, superior to that of the enemy. However, so much attention has been devoted by the press to this subject that many of our citizens, and even the press itself, have overlooked the fact that before equipment is of any real value in battle men must be trained to become expert in its use. It must then be properly placed and grouped in military units or teams; its upkeep and repair must be provided for; finally, the necessary up-to-date tactics and technique—comparable to team play and team signals—must be devised, prescribed, and taught if we are to bring out the full power of the combined arms and are to apply to the best advantage the military characteristics of any equipment. We cannot afford to overlook the extremely important facts that a high state of training and exceptionally well coördinated teamwork—on the ground and in the air—between all arms, old and new, certainly account for German successes as much as, if not more than, superiority in quality of equipment.



A 50-mm. Shell Hit on an M3 Tank Did Not Penetrate but an 88-mm. Shell Pierced the Armor

The two armies in the Middle East are both armored armies in the sense that they are completely motorized and mechanized and that all strategy and tactics are devised to use all elements in support of tanks. My opinions on our organization, training, tactics, and technique as compared with what I saw in the Middle East, are as follows:

In organization, our armored division is very similar in principle to the German *Panzer* division, but it is larger, contains more fire power and armor, possesses more speed, and is therefore capable of longer sustained action in combat and of greater radius of action.

In our training we have a splendid school system for officer and specialist. Our training aids are certainly equal to anything I have seen elsewhere. We stress maintenance of motor vehicles. We provide more liberally than any nation for target ranges and for target practice. We have overlooked no means or methods for training the individual soldier. We are giving him a far better preparation, thank God, than any other soldier has received in past wars—better than it was *possible* for the British to receive in the Middle East. Machine warfare is built to order for our nation and for our soldiers.

In tactics and technique we need no change. We stress speed, power, teamwork between all arms, and *offensive* action. From my observation in the Middle East, these principles cannot be overstressed. When they go right—and they must go right—they accomplish the maximum amount of killing of the enemy in the minimum amount of time. They win battles and campaigns speedily and are built now, as they always have been, to fit American temperament.

I cannot stress too strongly the necessity for providing well-trained maintenance units and adequate spare parts which are required in an active theater. Nor can any of us do too much to assist the Chief of Ordnance in his efforts to supply these essentials. The lack of maintenance units and of spare parts was one of the greatest handicaps facing the commander in chief in the Middle East. For example, a large percentage of both tanks and combat aviation present in this theater were not available for use in battle due to inadequate maintenance or lack of spare parts. At the same time, new planes and new tanks were arriving, only to become inoperative for the same reason after a few weeks in combat. It is obvious that such deficiencies in maintenance are intolerable from the point of view of efficiency, production, raw materials, and transportation.

Maintenance units should be organized, therefore, *concurrently* with combat units, and spare parts for military equipment must be produced and made available in an active

O. W. I.

THE NEW M4 "GENERAL SHERMAN" TANK (LEFT) AND THE M3 "GENERAL GRANT" (RIGHT)

This photograph clearly illustrates some of the improvements in the M4 model, especially the lower silhouette, all-welded hull with rounded contours, and the 75-mm. gun in the turret with 360-degree traverse. Both tanks shown in the illustration are equipped with rubber treads.

theater even if it is necessary to stop the production of complete units of equipment. In civilian life we cannot run our commercial transportation without garages and without the tools and spare parts for the operation of these garages. The same principle applies to military units. The commander in chief in the Middle East most likely would have won the last campaign had it been possible to give him more complete requirements in these matters.

In determining the spare parts needed in an active theater, consideration must be given to requirements resulting from hostile fire as well as those resulting from normal wear and tear. Many parts which never fail in maneuvers are shot up and must be replaced in battle. All the parts needed cannot be carried along on the battlefield with the unit. Prompt supply from stocks in the rear is frequently of vital importance. This prompt supply was effected in the Middle East through delivery by air from rear bases to front-line units. To be completely up to date we also must make provisions for supply by air transport. The impetus for maintenance, like supply, must come from *rear to front*—else it will fall down in battle.

The tempo and strain of modern warfare—the effort that must be made by troops in armored vehicles to get the maximum value out of their machines, which do not tire, and by accompanying troops to keep pace with these armored troops—make physical fitness of far more importance now than in past wars. To survive in battle against the highly trained, physically fit Japanese and German troops who revel in killing, our men must be able to endure great hardship, hunger, thirst, loss of sleep, and still remain physically and mentally alert to kill first instead of being killed.

The Middle East is a most interesting station aside from the opportunity to see active military operations. Cairo is now the crossroad between America, England, and Africa enroute to Russia, India, China, Australia, and New Zealand. There one meets military missions, envoys, military attachés and war correspondents from all allied nations, and refugees from conquered and Axis-occupied nations. The consensus of opinions may be summarized as follows:

THIS war against Hitler can be divided into three historical phases: In the first, Great Britain gallantly and bravely—and, after the fall of France, against almost hopeless odds—alone withstood all of Hitler's efforts to destroy freedom and democracy. In the second phase, from 1941 until the present, Russia, with amazing fortitude and great sacrifice, bears the brunt of this Nazi effort to conquer the world. In the third phase, now at hand, the United States, the wealthiest and most productive of all nations, must take up at least its fair share of the load, and, due to its delay in getting into action, probably more. Lend-Lease alone cannot win this war. The only safe premise to go on is that we will require every able-bodied man in the country under arms, the drafting of every man, woman, and child for use in the war effort, and possibly of every dollar we possess. I repeat—this is the consensus of opinion of many sound-thinking people about our war against Germany. But to get the full picture, we must also consider Japan and her designs to destroy us.

Men who have been through war know that the best equipment, training, tactics, technique, and strategy are of no avail to an army unless the individual soldier has the *will to win*. I assure you, too, that the present-day American soldier *has* this priceless attribute—not in a fanatical, showy way but with a certain calm, thoughtful, determined attitude that bodes our enemies no good. I believe, too, that this will to win, this will to sacrifice, must and does imbue every man, woman, and child in the nation, and will insure that we win this war promptly and decisively. There is no half-way measure, no compromise that can be suggested, talked, or considered. Win it we must! Win it we will!

Integration for Production

Industrial Committees as an Aid to Ordnance Manufacture

Brig. Gen. A. R. Glancy*

DECENTRALIZATION may well turn out to be one of the most far-reaching accomplishments of the administration of Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance. Soon after he assumed office on June 1, 1942, he transferred the Office of the Field Director of Ammunition Plants from Washington to St. Louis; the Safety and Security Branch to Chicago; the Small Arms Ammunition Suboffice of the Small Arms Branch to Philadelphia. Then, in the early fall, he started the boldest stroke of decentralization the country has yet seen in this war—the transfer of tank-automotive headquarters from Washington to Detroit. Over a period of weeks, great slices of his office were cut off and shipped from Washington to the Motor City where, on October 19, 1942, General Campbell officially activated the new Tank-Automotive Center.

Another phase of decentralization is the system of industrial integration committees originated by General Campbell. The possibilities of the committee system first became generally realized as a result of the remarkable accomplishments of the Mechanical Time Fuze Committee which General Campbell created before he became Chief of Ordnance. When the various companies struggling with the production of time fuzes started working together under the committee system, they found that their various shortages or excesses of machine capacity, materials, and other things balanced one another to a startling degree. By operating in coöperation under the Ordnance committee system, they were able to attain a great increase in production. Today, this system is a most important part of the operation of the Tank-Automotive Center, and it will become more important still.

How does the Ordnance committee system fit into this operation? The integration committees comprise manufacturers doing work for the Tank-Automotive Center. The committee system enables the plants making medium tanks, for example, to work together much as though they were one big tank corporation, rather than individual plants. This system may be better illustrated by describing three stages of the tank program.

When the country entered the period of crisis, the only ones who knew much about the design and manufacture of tanks were the Ordnance experts, such as Brig. Gen. G. M. Barnes, Brig. Gen. John K. Christmas, and those other Ordnance men who had built, at Rock Island Arsenal, the few tanks permitted by the small peace-time budget of the Department.

When the Ordnance Department was suddenly given funds and told to build many thousands of tanks, its engineers and the engineers of private industry found themselves with the staggering task of taking a tank which was hardly beyond the blueprint and pilot-model stage and working it quickly into quantity production.

The problems were brilliantly conquered by the teamwork of the Ordnance tank technicians, the officers of the Ordnance districts, and the engineers from private industry. As each problem was mastered, the Ordnance Department pooled the information and made it of benefit to all tank manufacturers. Then the tank manufacturers themselves were encouraged to exchange information and services with one another. This practice of exchange of information was formalized last July into the Medium Tank Production Committee comprising all manufacturers of tanks, which was able to follow the pattern set by the Mechanical Time Fuze Committee.

WHAT is the present stage of development of the Ordnance committee system? The Tank-Automotive Center now has seven committees, with General Christmas, assistant chief of the Center, as chairman of all and Col. Charles Deere Wiman as deputy chairman. Aside from having these two officers occupy those two positions with all seven committees, each committee is autonomous and independent of the other. The committees cannot act formally except by signature of the chairman or deputy chairman; hence it is assured that the companies within the committee cannot perform any act in combination prejudicial to the policies of the Ordnance Department. The seven committees are: Medium Tank, Light Tank, Half Track, Armor Plate, Armor Castings, Power Train, and Track. Some of these have subcommittees. Hundreds of companies, large and small, all over the U. S. are members of one or more committees or subcommittees.

The Medium Tank Committee is fairly typical. It is made up of one representative from each of the plants manufacturing medium tanks, plus the chairman, deputy chairman and an Ordnance captain from the Tank-Automotive Center who is stationed at the office of the committee. Ernest Murphy of the Pressed Steel Car Company, Chicago, is assistant chairman of the committee.

The Medium Tank Committee may be likened to a great merger of tank plants all combined under the trade-mark of the Ordnance Department and all making the same product—the American medium tank.

If one manufacturer is getting slow deliveries on tank tracks, the committee office will find out immediately if some other manufacturer has an excess of tracks so that a balance may be reached. Formerly, a manufacturer short on tracks would come to the Ordnance Department for information and guidance in finding a manufacturer who could help him out; now the manufacturer goes to his own committee headquarters, gets the centralized information, and then makes his deal directly with another manufacturer. Thus, we have taken that much of the job out of the hands of the Ordnance Department and put it into the hands of private industry, where it can be done more quickly.

Another and future phase of committee activity in the tank-automotive program is simply a continuing enlargement of the present phase. The Tank-Automotive Center has given to the genius and energy of private industry the maximum freedom of initiative that circumstances can allow in our job of delivering to the American soldier the best and most abundant tank-automotive equipment in the world.

*Deputy Chief of Ordnance, Tank-Automotive Center, Detroit, Mich. Brigadier General, Ordnance Department, U. S. Army.

Artillery Today

The British Find the Light Howitzer a Versatile Weapon

Maj. Gen. H. Rowan-Robinson*

ARTILLERY still retains its importance in modern war in spite of the many changes wrought by the internal-combustion engine. Frederick the Great said of it: "If formerly courage and morale of the combatants was sufficient to assure victory, today it is artillery that decides everything." Napoleon, who, though a gunner, had saluted infantry as the Queen of Battles, later said that battles are won by artillery. In more recent times, World War I has been called an artillery war, and since 1918 the proportion of guns in relation to infantry has more than doubled.

Guns manned by artillerymen run from the tiny 2-pounder to the monster 18-inch rifles. They include antitank and antiaircraft weapons as well as those designed for the services in the field, for use in sieges, and for use in coast defense. In this article, field artillery alone will be discussed.

The technical design of a gun is, of course, dictated by tactical requirements which demand, in varying degrees according to circumstances, power, range, endurance, and mobility. The first three of these qualities conflict, however, with the last, and as they are of no use unless the gun can be made available where wanted, must suffer certain limitations. Compromises, therefore, had to be effected which, until a recent date, resulted in two types of weapons being employed in the field—the gun and the howitzer.

This solution, however, was never regarded as satisfactory; so, for the best part of a hundred years, the scientific gun designer sought to combine the virtues of the two weapons in a single piece. As is often the case in matters of armament, several of the great powers simultaneously found a key to the problem—shortly, as it happened, before the present war.

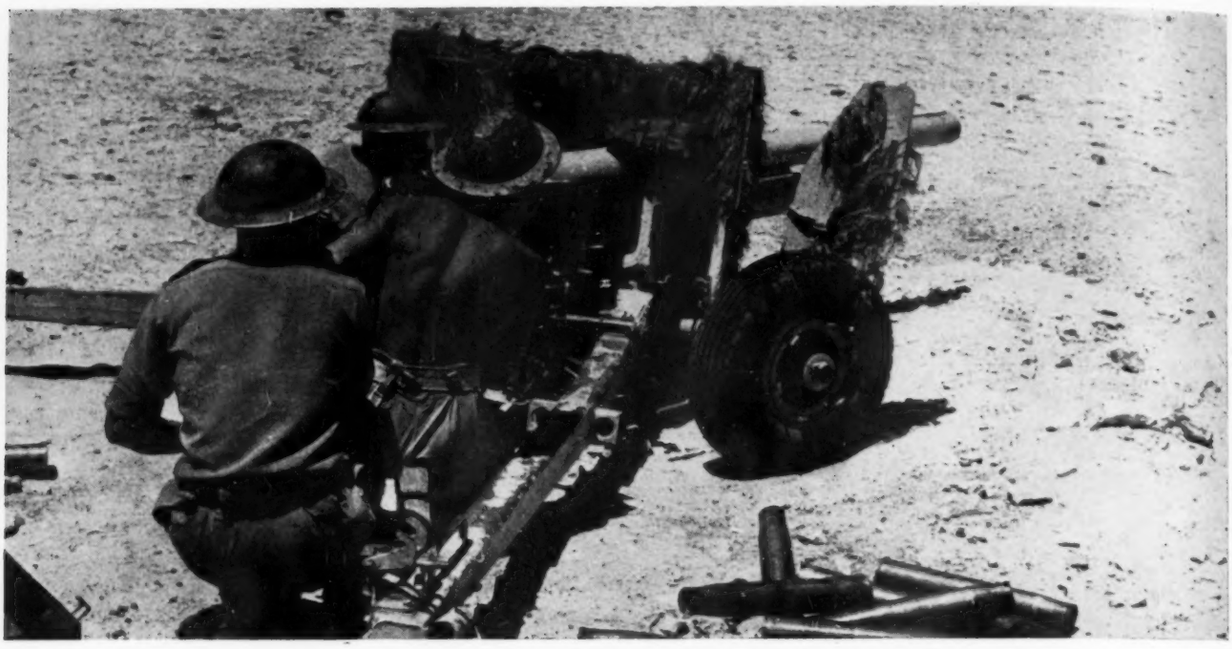
By 1939, Germany, having started from scratch, had completely rearmed her divisional artillery with the 10.5-centimeter gun-howitzer, and Britain was beginning to rearm with a 25-pounder of similar design (see illustration above). In general, these weapons, with their equipment, were somewhat heavier than their predecessors; but this point was of no great consequence because, as the motorization of artillery was becoming universal, an addition of a hundredweight or two behind the tractor was hardly noticeable. In these weapons, three or more charges were used, the smallest enabling curved supporting fire to be opened at short ranges and the largest giving a range of about 12,000 yards.

WHETHER or not this policy was sound is debatable. Reports from every front have spoken highly of the British 25-pounder, and the 10.5-centimeter appears to be a satisfactory, though not outstanding, weapon. Certainly the long range of the British 25-pounder is useful, for now that communication by radio has been perfected and a traveling observation post provided, support to other troops by observed fire can be afforded for some six miles beyond the firing line without change of position. Moreover, in defense the 25-pounder is valuable both for harassing fire and for allowing greater distribution in depth.

Those who object to this type of weapon regard it as un-

*Author: "The Campaign of Liao-Yang," "Artillery—Today and Tomorrow," "Some Aspects of Mechanization," "Further Aspects of Mechanization," "Security," "A Ministry of Defense," "England, Italy, Abyssinia," "Sanctions Begone!" "Imperial Defense."

Chief instructor in artillery, Royal Military Academy, 1911 to 1914; military governor of Libau, 1919; colonel commandant and G.S.O. 1, India, 1921 to 1927; inspector general of Iraqi Army, 1930 to 1934; operations in Southern Kurdistan, 1930 to 1931, North Kurdistan, 1932; battalion commander, British Home Guard; Gold and Silver Medalist, Royal Artillery Institution; Gold Medalist, and first and second Trench-Gascoigne Prize Essayist, Royal United Service Institution. Major General, British Army, C.B., C.M.G., D.S.O.

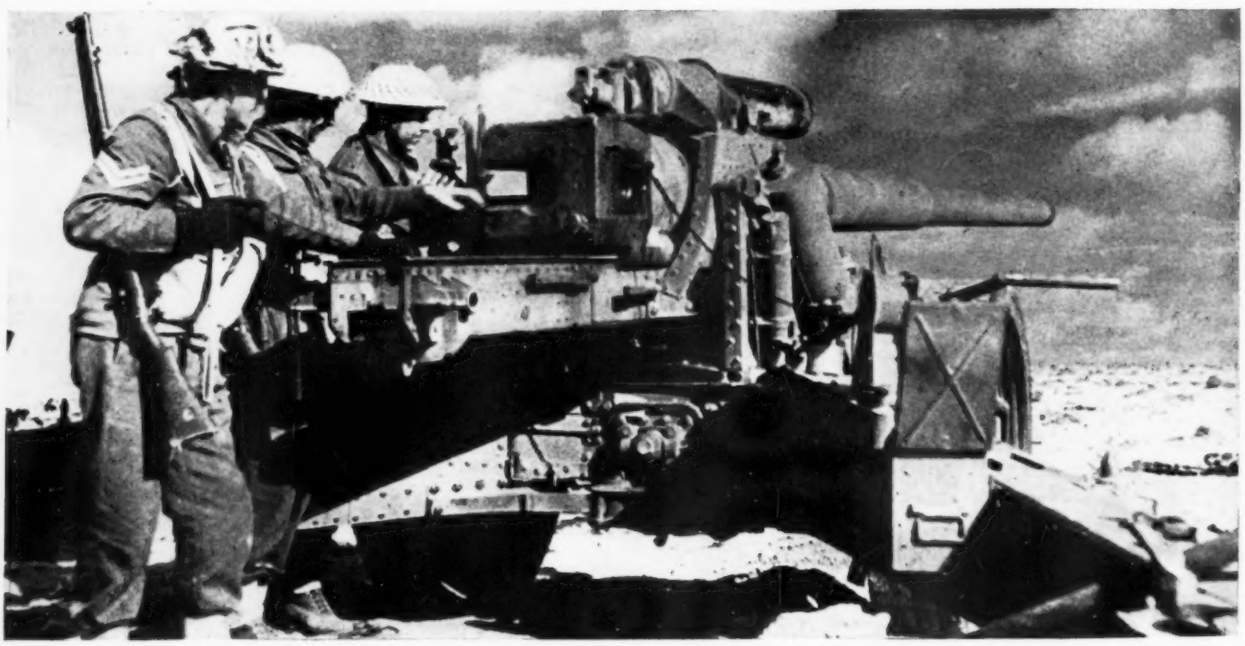


The New British 6-Pounder Antitank Gun in Action in Libya

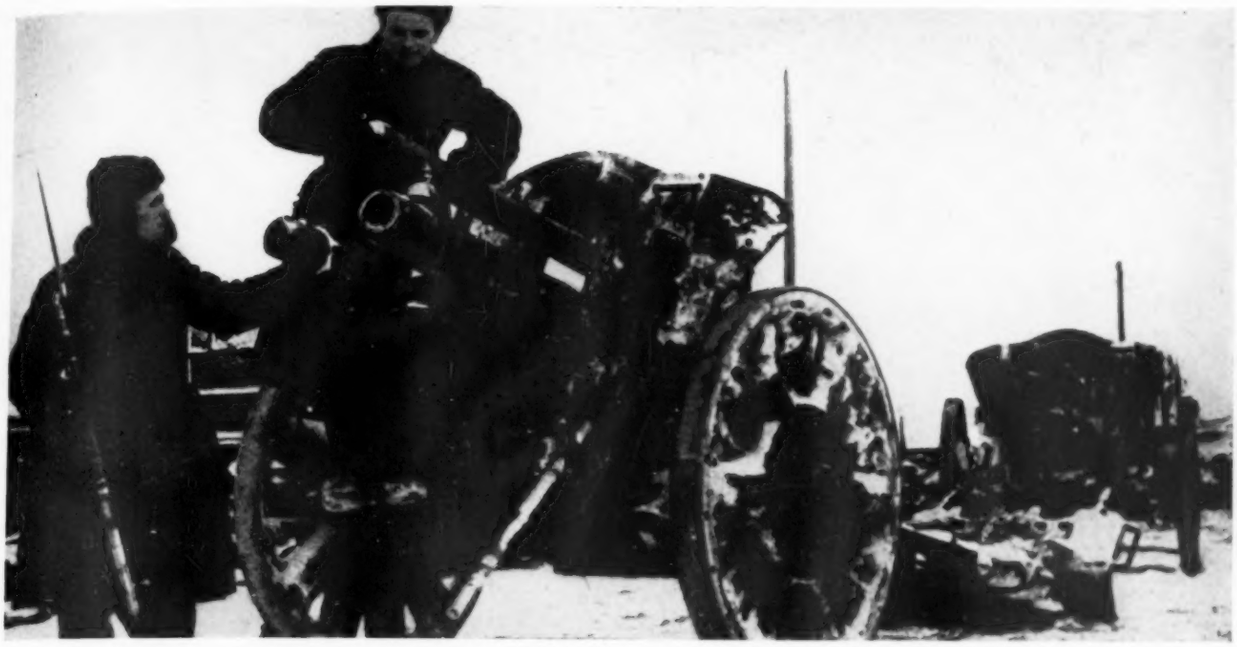
necessarily cumbersome for a battle in which, at any moment, any front may become the forefront. They object, too, to the low destructive power of its projectile compared with that of the field howitzer. Would it not be better in the first place, they suggest, to make use of one or more of the heavier types of weapon for the divisional artillery, such as Britain's 60-pounder and 6-inch howitzer? These are now very mobile and would give the same range combined with greater power. In the second place, they ask, why not introduce a smaller weapon than the gun-howitzer for other purposes? To answer these queries we must consider the nature of guns required in the field outside the divisional artillery.

The pack gun—2.7- to 3.7-inch—the piece and carriage of which can be divided into several loads and carried by mules, men, rickshaws, or light autos, has proved of great value in this war in the mountains of Norway and the jungles of Malaya, Burma, and the Netherlands East Indies. It can be taken across rivers and is thus a valuable component of a force detailed to secure and hold a bridgehead. Moreover, as it can be dropped easily in its several loads by parachute and carried in any kind of captured transport, it is a useful weapon to accompany air-borne troops. It is, therefore, likely to remain an important element of the artillery of an army, however much other weapons may have been motorized.

Of weapons of this nature, the British 3.7-inch mountain howitzer has shown itself *facile princeps* as regards range,



A German 15-Centimeter Howitzer Captured by British Troops in the Desert



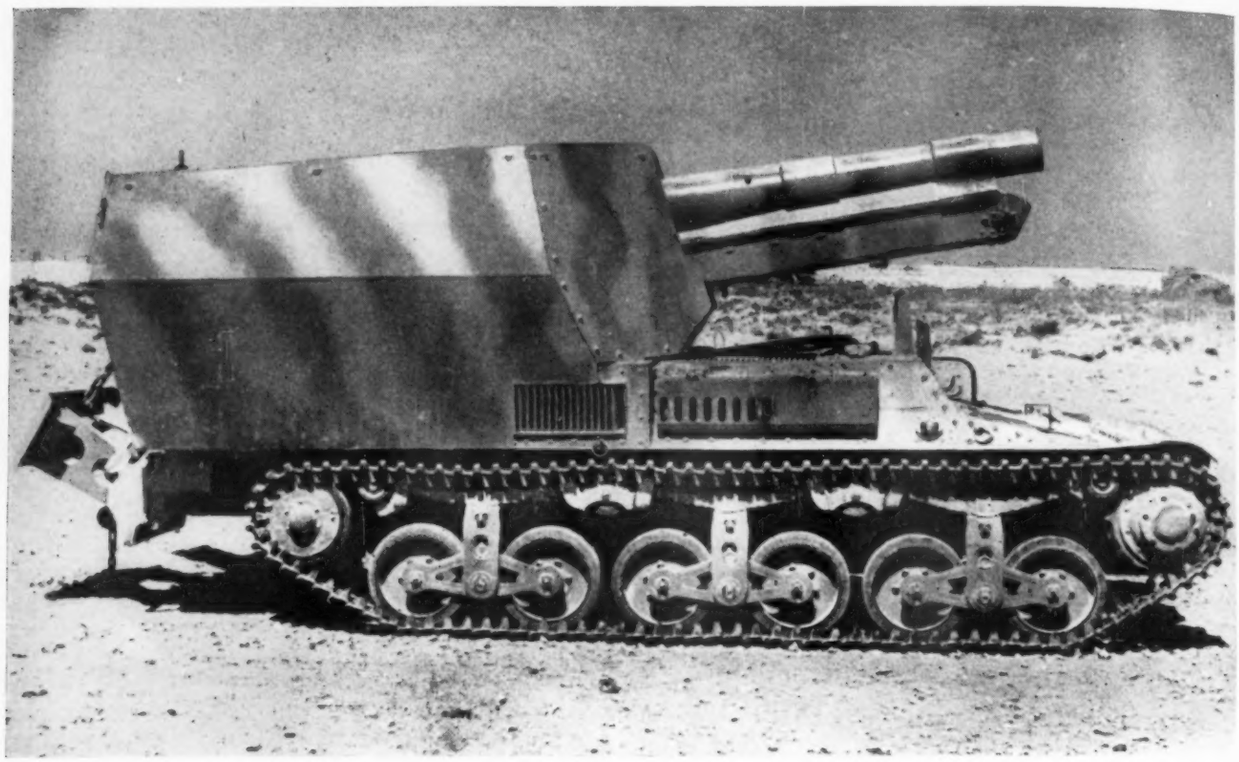
GERMAN 10.5-CENTIMETER HOWITZERS CAPTURED ON THE RUSSIAN FRONT

effect, and endurance. On the other hand, the Japanese have produced a weapon which, though of less power, has proved more generally mobile and of particular value in jungle warfare because of its light weight. It is simply constructed and hence is easily produced, maintained, and replaced—features which are becoming of increasing importance due to the ever-growing speed and destructiveness of modern warfare.

ANOTHER weapon in use outside the divisional artillery is the "gun of accompaniment." In World War I, the Germans found that their infantry, after being successfully launched on an attack by grace of bombardments and barrages, soon lost momentum owing to the fire of hostile machine guns. Because of difficulties of communication, these could not be quickly and effectively crushed by the divisional artillery. They therefore arranged for a few batteries of the lightest type of 77-mm. gun to follow close behind their leading troops for the purpose of knocking out machine-gun nests. This plan proved so successful that they adopted it again when building up their new army and went a step further by making six 7.5-centimeter howitzers and two 15-centimeter howitzers an integral part of the infantry regiment.

It will be noticed that they now prefer a light howitzer to a light gun. This is due, no doubt, not only to the fact that the howitzer can be made lighter than the gun for a pro-

BRITISH TROOPS PREPARE TO FIRE AN ANTIAIRCRAFT GUN. THE WEAPON ALSO MAY BE USED AS AN ANTITANK GUN



A NEW MODEL GERMAN ARMORED 15-CENTIMETER GUN ON SELF-PROPELLED MOUNT

jectile of given weight, but also because the gun generally has to be fired over open sights at short ranges, which often proves a costly process.

In connection with the various ways of employing artillery, we may take note of a marked feature of tactical organization in modern war. It is the "combat group"—a fighting force ranging in size from a platoon to a division. It is supplied with a sufficient variety of weapons to enable it to act independently, at least for a short period, in the execution of the task assigned to it. The combat group may contain rifles, tanks, field guns, and antitank guns.

The combat group is a corollary of the fluid battle and disappears with the advent of static warfare. Whether in attack, defense, or withdrawal, it can temporarily disregard the actions of formations on either flank. The fact that it is operating independently, however, indicates two requirements in its artillery: First, for close support in extension of that afforded by the "gun of accompaniment," some form of howitzer, lighter than the gun-howitzer, seems needed; secondly, since combat groups, from their nature and purpose, are subject to all-around attack, the weapon employed should be susceptible of very quick handling.

We now have enough data on which to base an answer to the proposal to discard the gun-howitzer and substitute both guns and howitzers. Under this proposal, medium guns and howitzers would be necessary in the divisional artillery. "Guns of accompaniment" and other forms of support would consist of light howitzers which would revert, except as regards regimental weapons, to divisional control when required for supporting an attack on strongly held positions.

Were such a change adopted, the processes of centralizing and decentralizing the weapons would be very complicated, and the introduction of so large a proportion of light howitzers would emasculate the artillery barrage. These are drawbacks which seem to outweigh any advantages inherent in the proposal. Moreover, existing mortars are excellent weapons and, operated as they are directly under the control of battalion commanders, can fulfill the dual rôle of accompaniment and close support.

Accordingly, it would appear that the type of gun in the British and German field artilleries is, in spite of various imperfections, reasonably appropriate to the needs of modern war, provided it be flanked on the one side, if necessary, by the pack howitzer and on the other by medium artillery. In all their campaigns of the present war, the Germans have relied for ground support on little else than the 10.5-centimeter gun-howitzer and their "guns of accompaniment."

IN Britain's desert warfare in Libya, she has found 25-pounders of such outstanding value that she builds small mobile columns around a section, troop, or a battery of them. They are the main weapons to tackle the heavier German tanks at longer ranges. They have, therefore, become the principal instruments both of offense and defense, and the tactics of the other arms are devoted to the two aims of protecting them and profiting from their fire. In an advance, the commander of the guns (or the forward observation officer) rides in an armored car close to the column or vanguard commander, ready to draw immediate profit from any opportunity that may occur. Once contact is made, the tanks never move to the attack unless sure that the guns are ready to support them, and the guns themselves are usually distributed in two echelons, half in action and half on the move.

In conclusion, the self-propelled gun should be mentioned. It has come to stay, but whether as a tank (an offensive weapon) or as an antitank vehicle (a defensive weapon) or as a field gun (a supporting weapon) has yet to be decided.

Maj. Gen. William Crozier

A Memorial to a Great Chief of Ordnance

MAJ. Gen. William Crozier, who retired in 1919 after over forty-three years of active commissioned service in the United States Army, passed away at his home in Washington, D. C., on November 10, 1942. Thus ended a brilliant career in the service of our country.

General Crozier, the son of Judge Robert and Margaret Atkinson Crozier, was born in Carrollton, Ohio, February 19, 1855. He was appointed to the United States Military Academy from Kansas and was sworn in as a cadet on September 1, 1872, graduating June 15, 1876, near the head of his class of forty-eight members.

Upon graduation, Lieutenant Crozier was assigned to the 4th Regiment of Artillery and received his first actual combat experience in the Campaign against the Sioux Indians in 1876 and 1877, and the Campaign against the Bannocks in 1878. He was commissioned in the Ordnance Department as a first lieutenant in 1881. Thus began service of a distinction attained by few officers in the history of the United States Army.

In 1890, he was promoted to the grade of captain. The breadth of his professional attainments was recognized by his appointment as the Military Delegate to the International Peace Conference at The Hague in 1899—Admiral Mahan being the Naval Delegate. He served in the field during the Philippine Insurrection and later, in 1900, was Chief Ordnance Officer of the Relief Expedition to Peking.

Captain Crozier was tendered the appointment as professor of natural and experimental philosophy at the United States Military Academy in 1901 but declined the distinction. In November 1901, he was selected by President Theodore Roosevelt, upon the recommendation of the then Secretary of War, Hon. Elihu Root, to be Chief of Ordnance. Thus began what was to become the longest tenure in the history of the Ordnance Department—a term of nearly seventeen years of constructive Ordnance service which was ended by his appointment as a major general of the line on July 12, 1918, upon his return to the United States from service in England, France, and Italy. On the same date he was assigned to the command of the Northeastern Department with headquarters in Boston, Mass. He held this command until his retirement on January 1, 1919.

During his tenure as Chief of Ordnance, he was on detached service as president of the Army War College from 1912 to 1913.

General Crozier was married to Mary Hoyt Williams of Washington, D. C., and New London, Conn., on October 31, 1913, at the Church of St. George, Hanover Square in London, by special license of the Archbishop of Canterbury.

General Crozier was an officer of marked originality and for more than forty years his engineering ability and creative talents exerted a progressive influence upon the fighting equipment of the United States Army. That today the armament of the American Army is acknowledged to be the best in the world is in no small part due to developments initiated and carried out by General Crozier. Not the least of these was his policy of promotion by selection and his comprehensive program of training of commissioned personnel.

November 11, 1942

MY DEAR MRS. CROZIER:

The news of the passing of your distinguished husband has just come to my attention, and this note is to extend to you my profound sympathy.

General Crozier leaves a record of service to country of which you may be proud indeed. His military career, marked by untiring zeal and devotion to duty, was outstanding, and the Army will long feel the influence of his important contributions in the field of armament development and progress.

Believe me, Mrs. Crozier, with kindest personal regards,

Yours very sincerely,

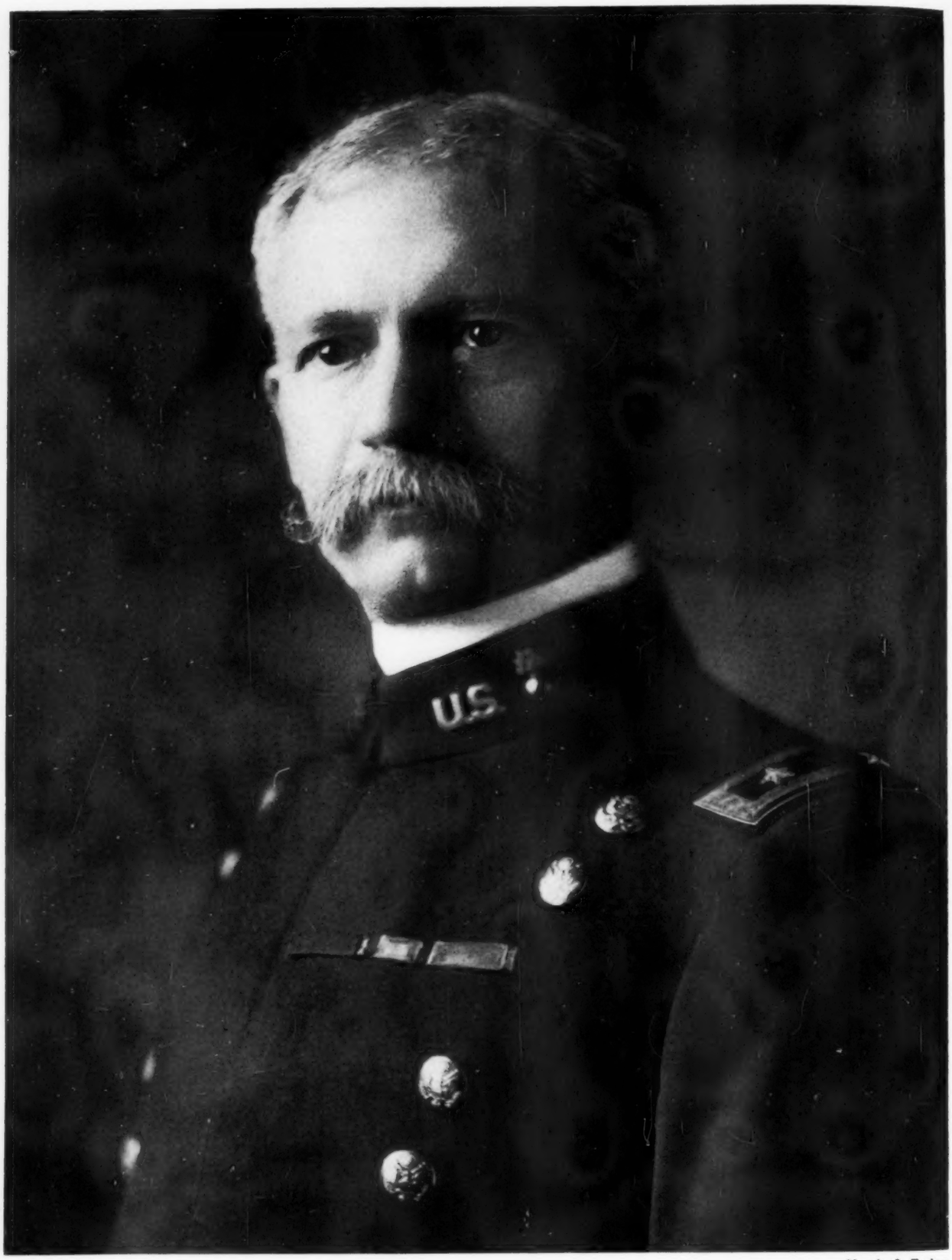
JOHN J. PERSHING

General Crozier's many contributions to the science of ordnance engineering included the following articles published in the official "Notes on the Construction of Ordnance": "On Winding and Dismantling an Experimental Wire-Wound Gun Cylinder"—Note No. 38, June 23, 1886; "Probability of Fire"—Note No. 47, January 20, 1888; "On the Rifling of Guns"—Note No. 49, September 19, 1888; "Design for an Experimental Carriage for a 7-Inch B. L. Siege Howitzer"—Note No. 57, January 12, 1891; "The Crozier 10-Inch Wire-Wrapped Rifle"—Note No. 87, submitted October 29, 1888, published May 28, 1906.

He was the author, also, of the important Appendices A and B to Capt. Rogers Birnie's Note No. 35—"The Resistance of Built-Up Guns and the Shrinkages Adapted to Their Construction," September 14, 1885.

These papers were the work of a vigorous and versatile mind pioneering in a field which, at the period in question, sorely needed investigation. At the same time, the young officer was carrying his full share of the heavy load of administrative responsibility devolving upon the small corps of officers of the Ordnance Department. During this period and later, his service included membership on the Ordnance Board, the Coast Defense Board, the Board of Ordnance and Fortification, and the National Advisory Board on Fuels and Structural Materials, and authorship of the book "Ordnance in the World War."

When the rehabilitation of the coast defenses of the United States was undertaken under the provisions of the Act of Congress of September 22, 1888, Col. A. R. Buffington (later General Buffington and Chief of Ordnance) and Captain Crozier, in collaboration, designed the Buffington-Crozier disappearing gun carriage. This became the most successful of all disappearing gun carriages and remained the standard carriage for all our large-caliber seacoast guns until after World War I, when the development of aircraft powerful enough to carry heavy bombs for great distances rendered parapets ineffective. Simultaneously, modern improvements and the perfection of spring and hydropneumatic recuperators made it practicable (*Continued on page 80*)



Harris & Ewing

MAJ. GEN. WILLIAM CROZIER, 1855-1942

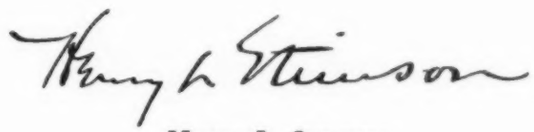
Chief of Ordnance, United States Army, 1901-1918

A Tribute from the Secretary of War

It is very fitting and appropriate that ARMY ORDNANCE *should devote itself to a memorial of General Crozier. He was one of the outstanding figures in the development of American ordnance and his name will always be connected with the invention of the disappearing gun carriage with which, until the advent of the airplane, the principal guns in our coast defenses were equipped.*

But he was far more than an expert in ordnance—he was an experienced and gallant soldier with a keen analytical mind as well as breadth of vision, which made his counsel in general military matters of very great value. Thus in 1912, although a permanent Staff officer, he was selected for service as head of the Army War College, and as such took a prominent part in the discussions resulting in the "Report on the Organization of the Land Forces of the United States," that historic study out of which came the first tactical organization of an American army in time of peace and which, several years later, by the personnel and principles which it brought to the front, assisted General Pershing in the creation of our Expeditionary Force of the World War of 1917.

After his retirement and throughout his long life, General Crozier retained a vigorous interest in both military and international affairs and his intelligent views on all such matters were a constant source of pleasure to his many friends. He was a typical American soldier of the highest type; one in whom professional distinction was supported and balanced by the broad vision of a most intelligent citizen.



HENRY L. STIMSON
Secretary of War

December 10, 1942

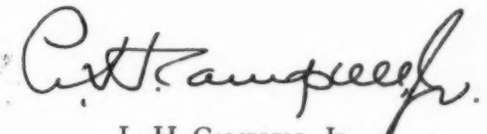
A Tribute from the Chief of Ordnance

My dear Mrs. Crozier,

Upon my return to Washington from abroad, I learned the sad news of General Crozier's death. I am especially sorry that I could not be here in person to join with his other friends and admirers in a last tribute of affection.

Each passing day in the tremendous Ordnance effort in this war brings home to me the marvelous influence of General Crozier's life and work upon the United States Army. Great was his contribution to the Ordnance Department through the design and the development of superior weapons for our national defense. Even greater is the type of thinking and acting which the Department inherited from him and which it uses constantly now to its advantage. These are priceless heritages, long to be cherished.

In your great sorrow, I hope you will take some measure of consolation in the knowledge that we of the Ordnance Department, to a man, revere your great husband for what he did, and we treasure his memory for what he will always mean to us. Sincerely yours,



L. H. CAMPBELL, JR.
Major General, Chief of Ordnance

November 23, 1942

to provide barbette carriages permitting higher elevations than were possible when the disappearing carriage was the principal weapon of our coast defenses.

Recognizing the complete interdependence of the Army Ordnance Department on the one hand and civilian science, engineering, and industry on the other, General Crozier was an outstanding advocate of industrial preparedness long before that term had acquired any real meaning for the general public. To the extent that the small size of the Ordnance Department and the limited funds available for the purpose made it possible, he organized the Department for emergency service in the field long prior to the entry of the United States into World War I.

After our entry into that war, when General Crozier had gotten the program for the production of ordnance well under way, President Woodrow Wilson made him a member of the War Council. He went to Europe in January 1918 where he visited the British, French, Belgian, and Italian fronts for the purpose of noting the performance of ordnance in actual combat. Upon the organization of the Supreme War Council at Versailles, General Crozier, with Winston Churchill, then Minister of Munitions of Great Britain—now Prime Minister—developed the basis for the complete and effective pooling of all ordnance equipment for the Allied Armies. This included what was later known as the Anglo-American Joint Tank Program.

General Crozier was one of the first American officers to visit the Italian Front. At the request of King Victor Emmanuel, III, to stimulate the morale of the Italian Army after the debacle at Caporetto, he inspected practically the entire front from the Alps to the Venetian Gulf.

After his retirement, General Crozier, accompanied by Mrs. Crozier, spent much time traveling. They made three trips around the world, visiting China, Japan, the Philippines, Indo-China, Cambodia, Java, the Malay States, Burma, India, Egypt, Palestine, South America, Iceland, Spitzbergen, Norway, Sweden, Russia, East and South Africa, Australia, New Zealand, and Alaska. General Crozier's intellect and his piercing eyes never lost their keenness, and his interest in ordnance and international affairs continued unabated up to his final illness.

In addition to being awarded campaign medals for Indian wars, Philippine service, and service in China, General Crozier was decorated as Commander of the French Legion of Honor, Commander of the Order of Saints Maurice and Lazarus of Italy, and Commander of the Polish Order of Polonia Restituta. He was a member of the American Association for the Advancement of Science, of the Metropolitan, Army and Navy, and Chevy Chase Clubs of Washington, D. C.; and of the University Club of New York City. The degree of doctor of engineering was conferred upon him by the University of Michigan in 1923.

General Crozier was a founder of the Army Ordnance Association and one of its staunchest supporters. He was present, whenever possible, at the affairs of the society and was often called upon as a speaker at Ordnance gatherings. He was a national director of the Association, a member of its Washington Post, and a contributor to ARMY ORDNANCE (see page 103 of this issue). In 1931, the Gold Medal of the Association was awarded to General Crozier "for achievement in the invention, design, development, and manufacture of military armament." In 1941, in further recognition of his great services to the cause of national defense and American preparedness, the Association established the Crozier Gold Medal to be awarded for outstanding service in the field of American ordnance progress.

November 11, 1942

DEAR MRS. CROZIER,

On behalf of all personnel of the Ordnance Department, I hasten to send condolences to you upon the death of General Crozier. His personality and marked influence on ordnance progress have been such a part of our effort in this war, that we are all grieved. Your loss and ours are both very great.

General Crozier's place in the development and progress of American ordnance is not excelled by that of any other one person. His ability as an engineer, administrator and executive was apparent in every phase of Ordnance operation during his long service in the Department. His tenure as Chief of Ordnance was marked by leadership seldom equaled in our military annals.

In addition to all this were his outstanding qualities as soldier, counselor, and friend. Those of us who served under him, which honor was also mine, can testify abundantly to this. Accept, please, our deepest sympathy.

Sincerely yours,

T. J. HAYES
Major General, Acting Chief of Ordnance

On Friday, November 13, 1942, General Crozier was laid to rest at Arlington after a private religious service at his home. At the Fort Myer Gate, a group of several hundred Ordnance officers assembled to march behind the flag-draped caisson to the General's final resting place as a touching tribute of honor and respect to a great Chief of Ordnance. Among the honorary pallbearers were: Hon. Harlan F. Stone, Chief Justice of the United States Supreme Court; Hon. Charles Evans Hughes, Chief Justice of the United States Supreme Court, Retired; Hon. Henry L. Stimson, Secretary of War; Dr. Stanley K. Hornbeck, advisor to the Secretary of State; Maj. Gen. Thomas J. Hayes, Acting Chief of Ordnance; Maj. Gen. C. C. Williams, Maj. Gen. William H. Tschappat, and Maj. Gen. Charles M. Wesson, former Chiefs of Ordnance; Brig. Gen. Benedict Crowell, president of the Army Ordnance Association; Hon. Bernard M. Baruch; Mr. Laurence V. Benét; Mr. Corcoran Thom; Mr. Charles Warren; Hon. Thomas M. Wilson; Lieut. Gens. Thomas Holcomb and Lesley J. McNair; Maj. Gens. James H. Burns, Charles T. Harris, Jr., Russell L. Maxwell, Frank R. McCoy, and Harry K. Rutherford; Adm. Joseph Strauss; Brig. Gens. Gladeon M. Barnes, John Ross Delafield, Alexander G. Gillespie, Ulysses S. Grant, III, Roswell Hardy, Julian S. Hatcher, John W. Joyes, James Kirk, Burton O. Lewis, Earl McFarland, Hugh Minton, Norman F. Ramsey, Hermon F. Safford, Herman Schull, Roland P. Shugg, Richard H. Somers, Sidney P. Spalding, Charles Elliot Warren, Gordon M. Wells, William I. Westervelt; Cols. William A. Borden, Morgan L. Brett, William W. Coleman, Francis H. Miles, Jr., Frederick H. Payne, Frank A. Scott, James L. Walsh; Lieut. Col. Leo A. Codd; Lieut. Arthur K. Watson.

Letters from the General of the Armies, John J. Pershing (p. 77); the Chief of Ordnance, Maj. Gen. Levin H. Campbell, Jr., (p. 79); and the Acting Chief of Ordnance, Maj. Gen. Thomas J. Hayes (above), were among the many messages of condolence and sympathy received by Mrs. Crozier from General Crozier's many friends and acquaintances in all parts of the world. A memorial tribute to General Crozier from Secretary of War Stimson appears on page 79.

Heavy Ordnance

ALTHOUGH the airplane has changed the face of modern warfare in many respects, the 16-inch coast-defense gun still plays an important part in protecting our shores against invasion. Experience in the present conflict in the Philippines, in the Solomons, and in North Africa has shown that a large, well-guarded convoy, through either sheer weight of numbers or surprise, can push home landing attacks against a shore that is not defended with heavy seacoast artillery. the steaming jungles of the Caribbean area where they are protecting our shipping routes to the vital Panama Canal. Dubbed the "Jungle Mudders" because of their ability to work in the tropical forests, these troops, serving without fame or glory in their secret outposts, deserve the praise of every American.

The huge seacoast guns and mounts are the products of the Ordnance Department. Many of the guns are made at Water-

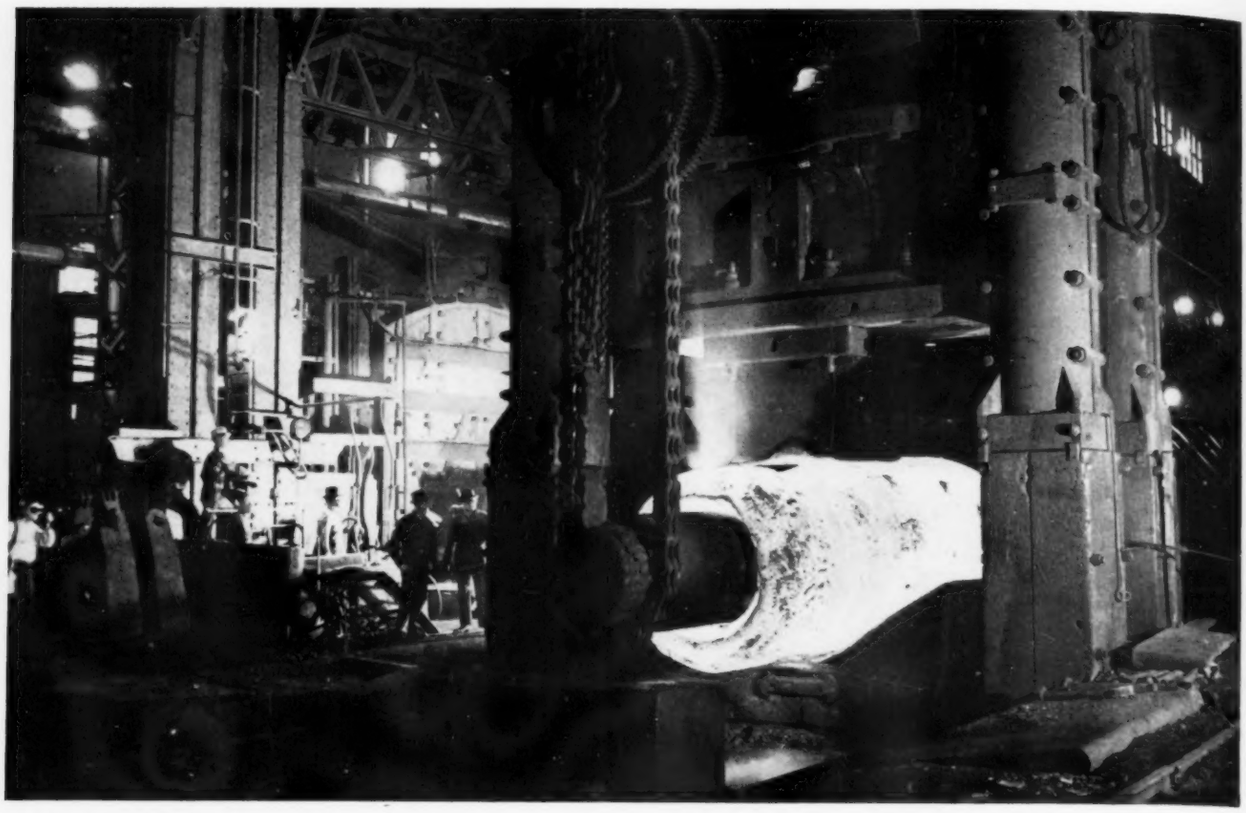
Our own coast defenses, including the 16-inch rifles, form the third and innermost ring guarding our shores from seaborne attack. The Navy, as always, forms the first line with its surface vessels and submarines constantly on the alert to intercept a hostile force while still on the high seas. Our heavy bombardment airplanes constitute the second ring, and they will begin attacking an enemy convoy while still hundreds of miles from our coasts. But should some enemy ships escape our Navy, and should unfavorable weather hamper the work of the bombers, our shore guns will speak with authority while the hostile force is still thirty miles at sea.

These guns naturally are concentrated around our main harbors, the Panama Canal, and wherever the enemy could effect a landing with heavy equipment and supplies. They must be protected from air attack by camouflage or fortification, and ground troops must be on guard against parachutists and possible rear attack by secretly landed forces. The men of the Coast Artillery have done a particularly splendid job in establishing posts and emplacements for the big guns in

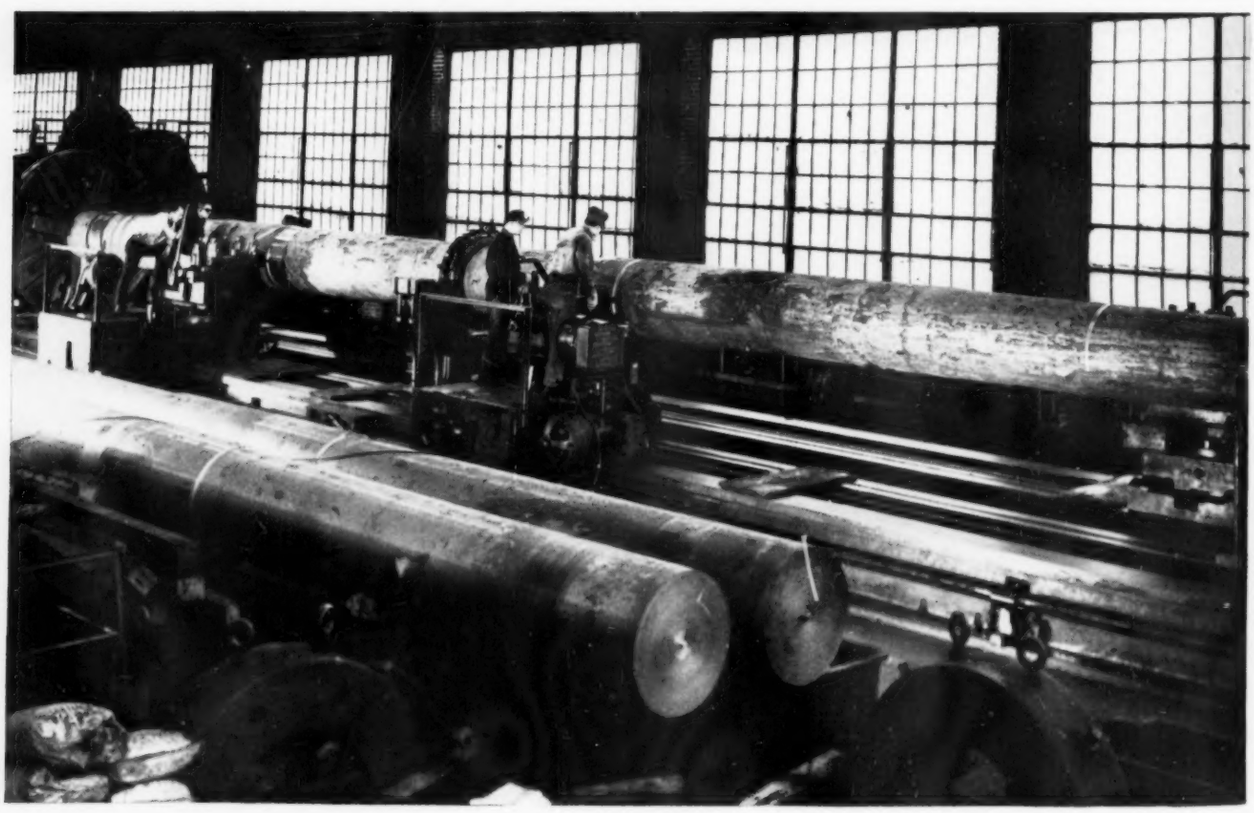
vliet Arsenal, established in 1812 and America's premier cannon factory since 1889. During the years of peace, this and other Ordnance arsenals kept alive the art of arms making, so that when the present crisis came they could swing into full production and pass on to private industry the knowledge and technique of munitionment of which they had been the sole custodians.

As a result, today the Ordnance arsenals are still setting the pace in many fields of arms production. More cannon were made at Watervliet Arsenal between January 1940 and January 1941 than the total cumulative output during the entire history of the arsenal up to the former date, and this rate has been progressively stepped up ever since. The arsenals have pioneered or improved many developments in gunmaking including the broaching process of rifling, the separate rifled liner, the cold-working process, honing, and high-speed reaming. The accompanying illustrations (from Signal Corps photos unless otherwise indicated) show various stages in the manufacture of 16-inch rifles for seacoast defense.

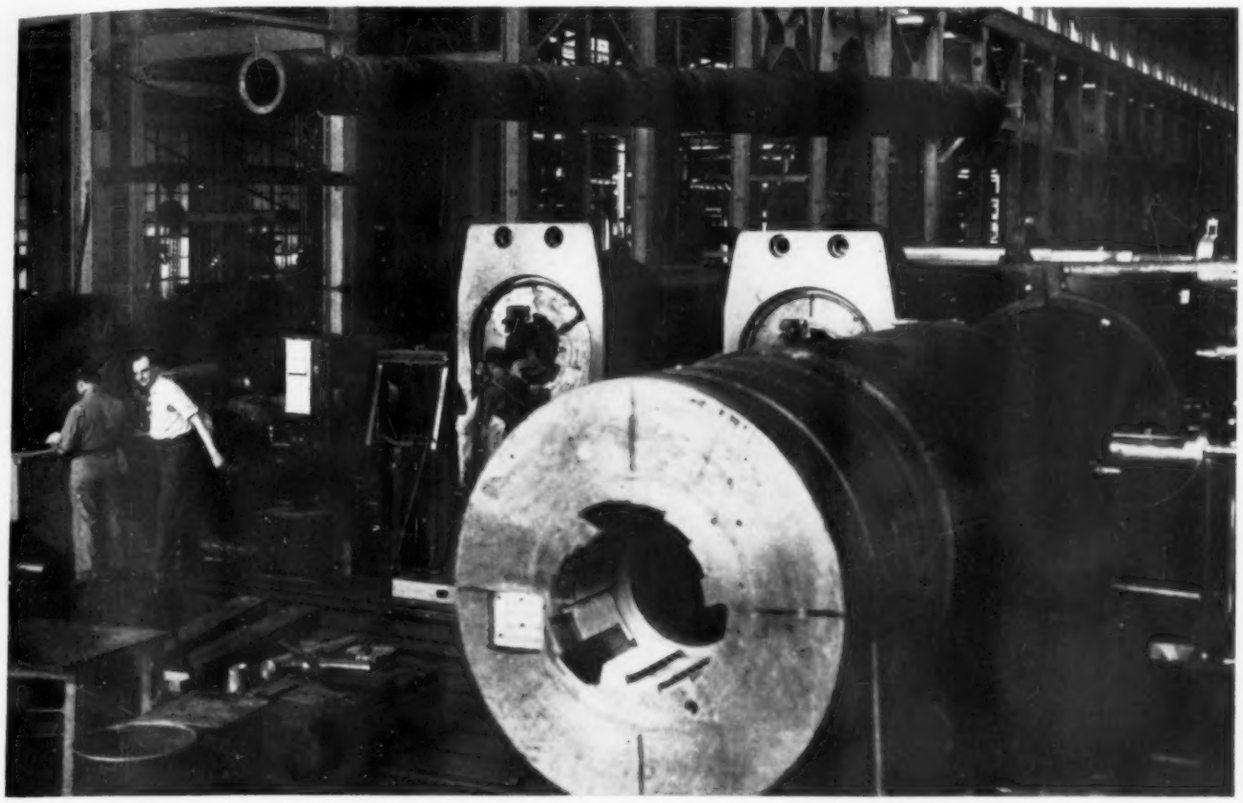
A 16-Inch Gun Takes Shape



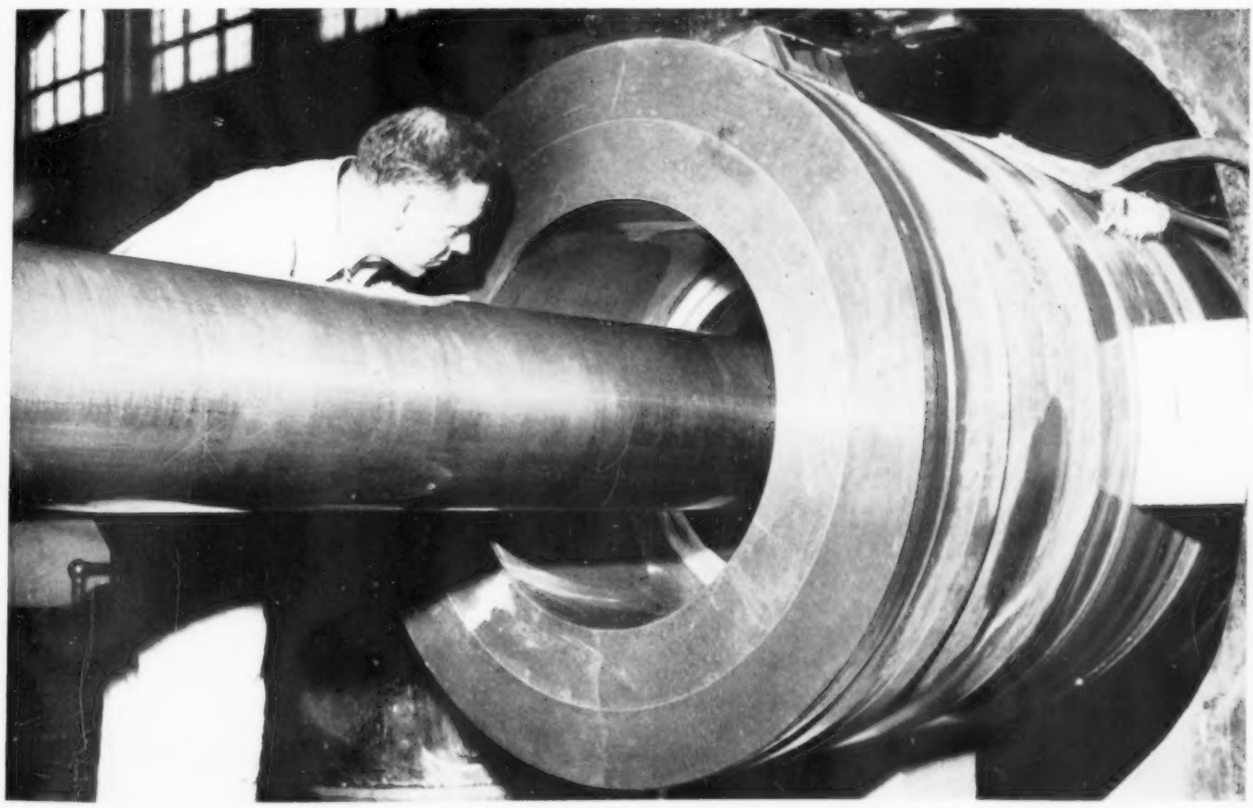
The white-hot mass of steel shown in the photo above is being forged into a 16-inch gun tube. The steel is rotated on the mandrel as the giant press forges it into shape. The rough forging is then sent to an arsenal where it will be turned into a finished weapon. Below, machinists make staging cuts preparatory to rough turning the tube (Bethlehem Steel photos).



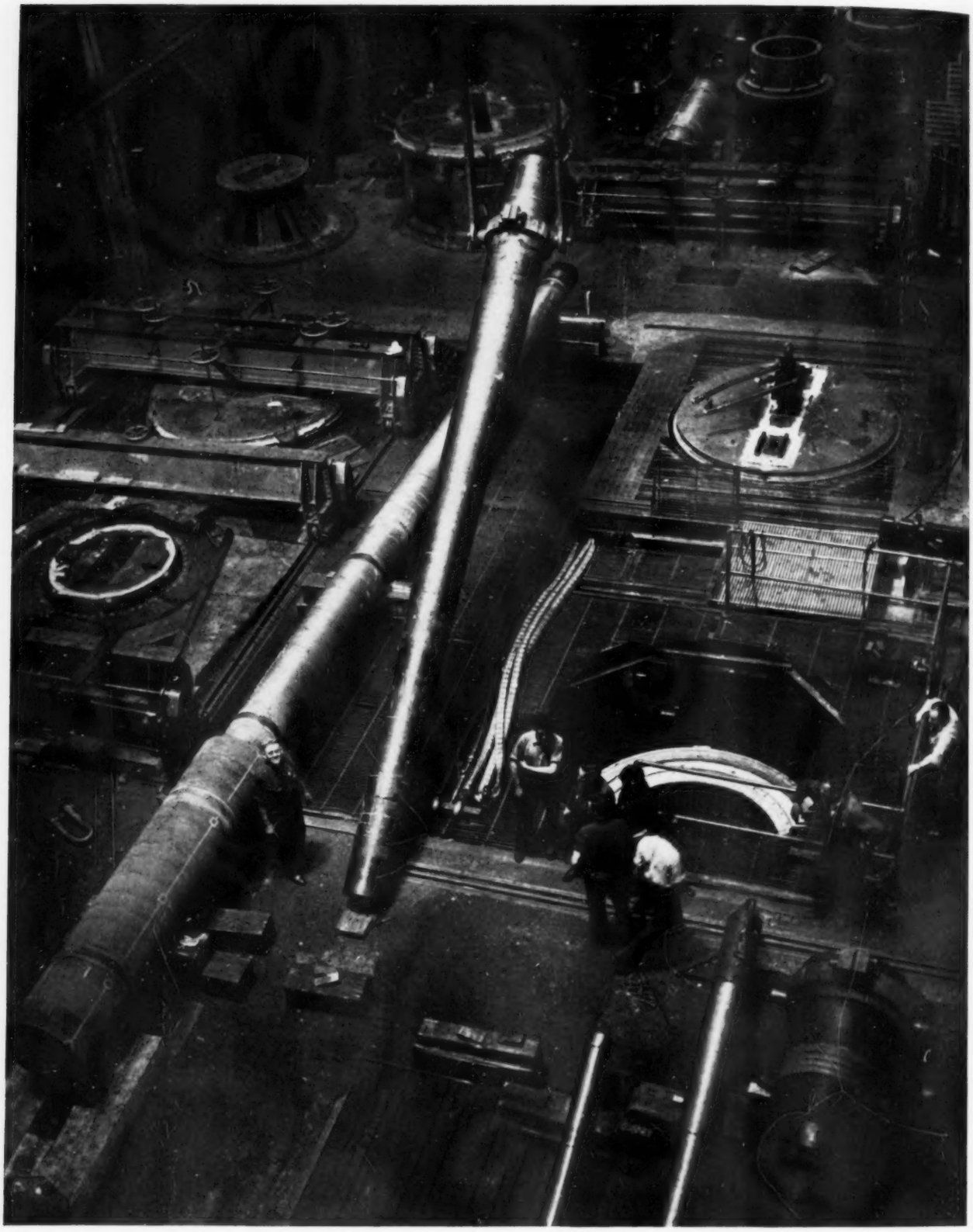
Ordnance Arsenals Machine the Big Rifles



Major-caliber guns are shown above in various stages of completion at an Army Ordnance arsenal. The interrupted threads in the breech of the gun in the foreground are clearly shown When the breechblock is installed, its interrupted screw will mesh with these to form a gasproof lock. Below, a workman inspects the finish boring of a coast-defense rifle (OEM photo).

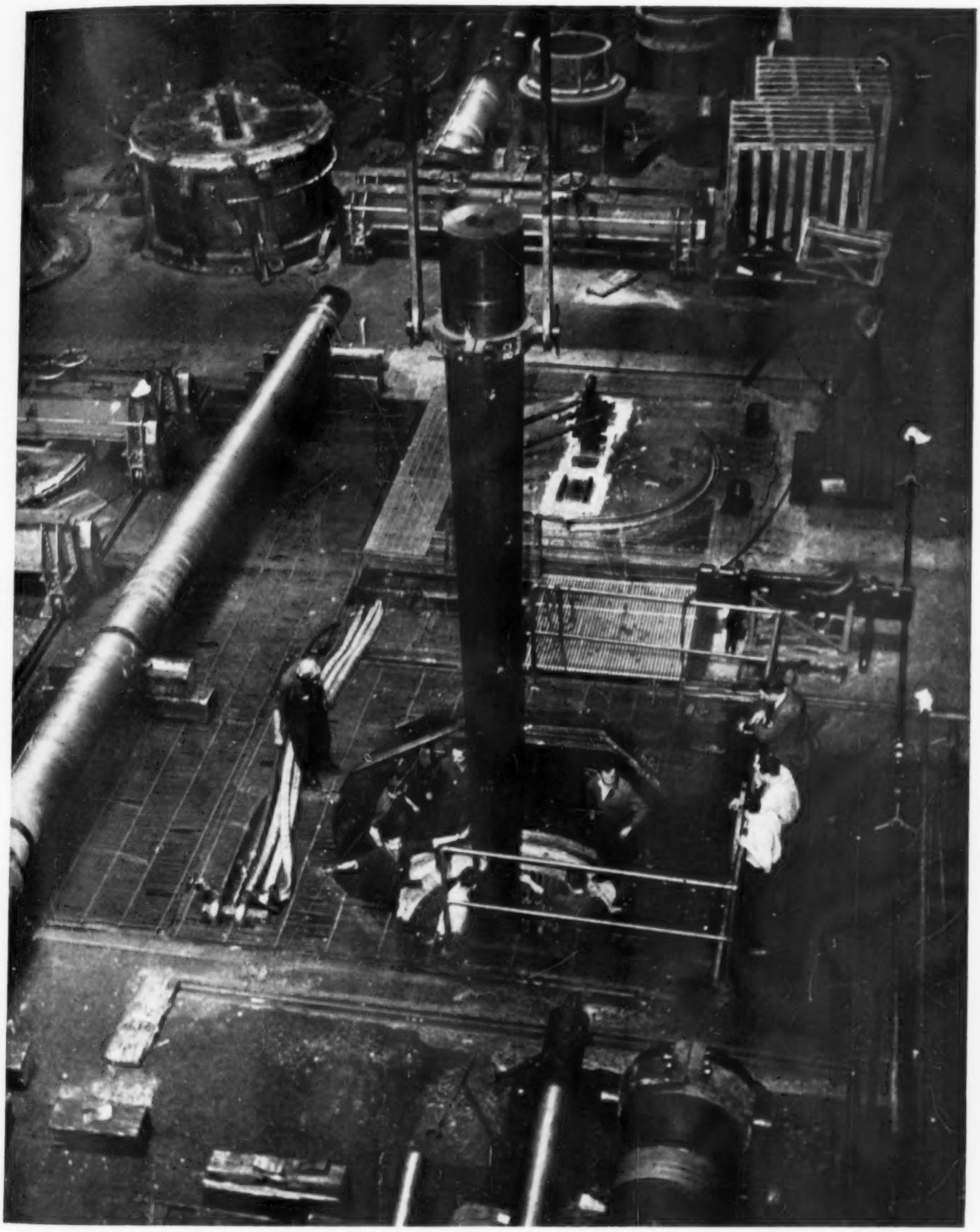


Preparing to Lower the Tube—



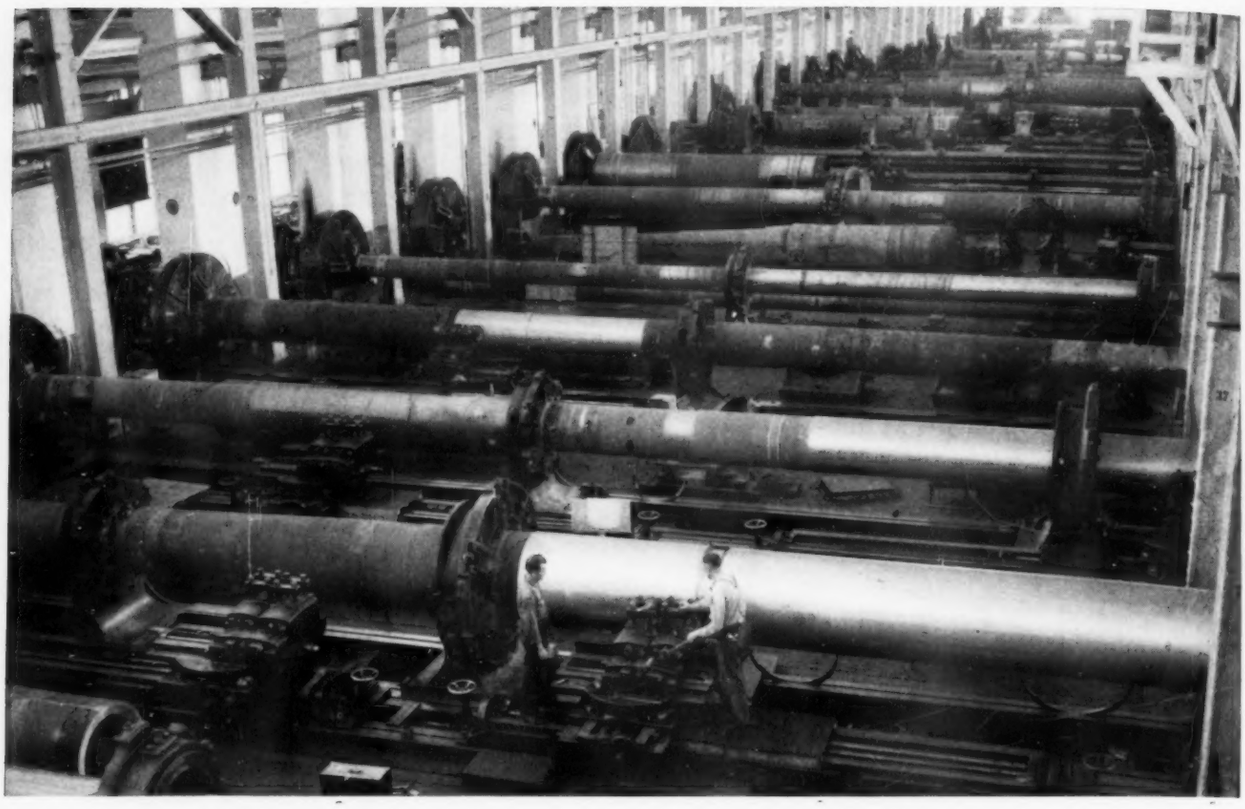
At an Army gun factory, workmen prepare to lower the tube of a 16-inch gun into one of the "shrink pits" where it will be heated and then be built up by having metal bands and hoops shrunk over it in varying thicknesses to give the necessary strength to withstand the terrific pressure developed when the gun is fired with its full powder charge.

—Into the Shrink Pit



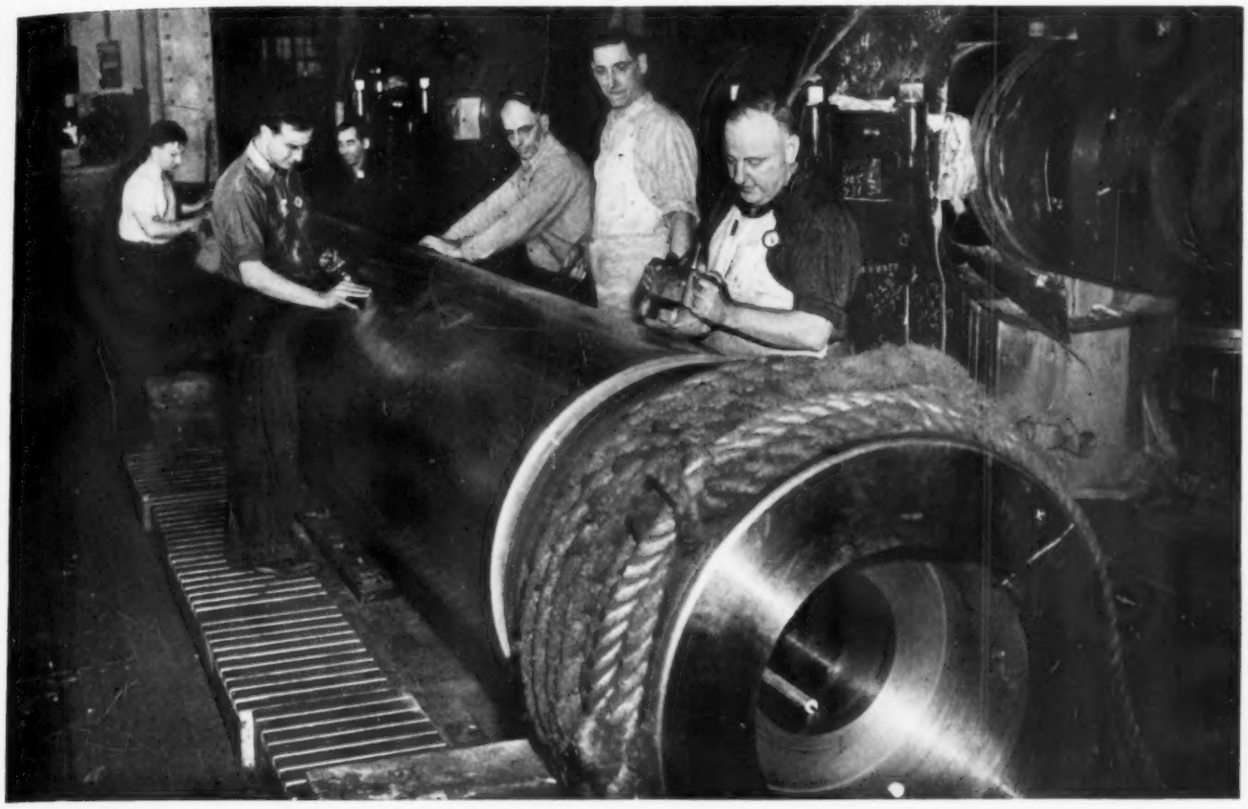
Above, the tube is about to be lowered into the pit where it will be heated by the electric coils which line the inside of the pit. Reënforcing bands will be shrunk onto the tube later to enable it to withstand the force of 110,193 foot-tons of energy generated when the gun fires its 1-ton projectile at the enemy at a range of approximately 30 miles.

Mass Production for Coast Defense

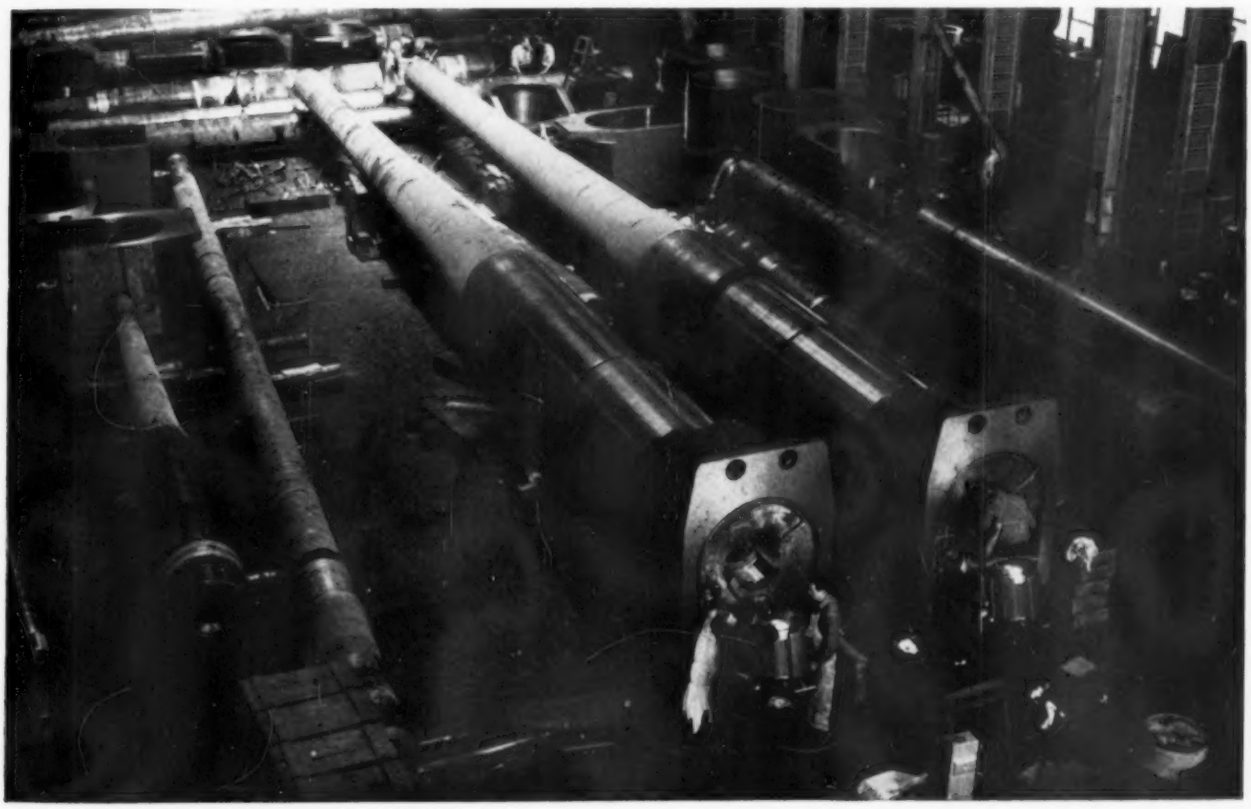


The illustration above shows a long line of big guns being ushed to completion at an Army arsenal. Before machining a gun, spotting cuts are made at various intervals along the tube as concentric guides for rests which support it as it is turned. The size of the big rifles is indicated by the inspector below, who is measuring the jacket of a 16-inch gun.

Skilled Workers Insure Perfect Weapons



Workmen, above, use hand tools and electric sanders to polish the cradle surface of a 16-inch gun. Below, two guns are shown with the breech mechanisms installed, almost ready for shipment. These rifles are 68 feet long and weigh, with carriage, nearly 900 tons. Giant cranes are needed to move them, and special railroad cars are required to transport them.



On the Firing Line

Finally installed in a jungle emplacement somewhere in the Caribbean area, the 16-inch gun above is ready to speak out for the defense of the Panama Canal. The mechanism of the mechanical rammer is shown at the rear of the gun. After firing, the Coast Artillery crew, below, prepare to reload the huge rifle with its powder charge and 1-ton projectile.

Circassia—Key to Conquest

Are the Caucasian Oilfields the Achilles' Heel of Soviet Power?

Brian O. Lisle*

MANY look upon the German drive to the Caucasus purely as Nazi strategy aimed at the capture of additional sources of petroleum. This is in part true, but motives behind the *Drang Nach Osten* are even stronger and more deadly than that. Tempting as the oilfields may be as a military prize to a potential conqueror, their real strategic importance lies not so much in their capture by the Axis as in their being wrested from the control of the Russian forces. Even should the Nazis fail to seize the oilfields for themselves, they will have achieved a tremendous victory should they succeed in demolishing them, cutting them off, or forcing the Russians to destroy them. Any of these accomplishments would serve to deprive the highly mechanized Red Army and the Soviet's essential war industries of their regular supply of petroleum products from the Caspian Sea areas.

Germany's chief objective must, in reality, be the complete bottling up of the Caucasian oil regions as far as supplies to interior Russia west of the Urals are concerned. Without these supplies, the Soviet forces would be badly crippled—in time, decisively so. Successful occupation of the Caucasus would mean the creation of a new base for the big push to join hands with the other major Axis partner, Japan, through Iran and via the Persian Gulf, or through Afghanistan and India—potentially disastrous to the efforts of the United Nations.

Let us look at the picture a little more closely in its broader implications. Under the Soviet régime and the three great *Piatiletkas* (Five-Year Plans), Russia has become the world's most highly mechanized nation, with the possible exception of the United States. Her huge collective farms have been established on the principle of mass production, using tractors and other self-powered agricultural machinery, all dependent upon internal-combustion engines. Industrial development likewise has proceeded apace, utilizing the easily transported and economical petroleum fuels. Also of major importance to her war effort, Russia's huge army is largely dependent on its vast number of tanks, mechanized artillery, motorized infantry, and the striking power of its air arm. Considering the comparative scarcity of coal fuel and of draft animals for traction, Soviet Russia in neither peace nor war can afford to lose control of her great oil-producing and refining centers.

For many years now, Russia has been consuming nearly all her oil production, and imports of American petroleum to her Far Eastern outposts have virtually offset her diminishing exports to such countries as Turkey and Iran. Thus, in the face of an almost evenly balanced supply-demand ratio, we must take into consideration the fact that the three principal oilfields (having a combined production of 523,000 barrels daily) are centered in a comparatively small area—81 per cent of the total Russian output comes from the Caucasus.

During the past decade, the leaders of the U.S.S.R. have encouraged the development of other oilfields in an endeavor to decentralize production of petroleum as much as possible. As far as is known, no signal success has been made in this direction, although some improvement is noticeable. The principal Soviet oil-producing areas are: (1) The Caucasus, with fields at Baku, Grozny, Maikop, Daghestan, and Kuban-Black Sea; (2) The Eastern Base, with fields at Bashkiria, Emba, Ishembayevo, Sizran, Aktiubinsk, and Buguruslan; (3) Other fields at Turkmen and Sakhalin Island.

As already mentioned, most of Russia's oil comes from the Caucasus. Let us enlarge upon this. The Caucasus is the isthmus between the Black Sea and the Caspian Sea, bounded on the north by Astrakhan and on the south by Turkey and Iran (Persia). It has an area of 272,000 square miles and is divided into an extensive mountainous region and vast steppe lands (plains). The mountain ranges extend for some 1,000 miles from the Taman Peninsula on the Black Sea, where the peaks have an elevation of about 400 feet, and gradually ascend as much as 18,500 feet in height toward the interior, finally declining into the Apsheron Peninsula on the Caspian Sea. Thus the Caucasus may be considered as divided into two parts by a chain of rugged mountains varying in width from 30 to 140 miles, through which there are but a limited number of passes. The north Caucasus is known as Circassia, and the south as the Transcaucasus (see map on page 91).

Baku oilfield produces some 440,000 barrels of crude oil daily, or about 68 per cent of the nation's total output. The oilfield region begins eight to ten miles from the city of Baku, on the Apsheron Peninsula. The city is separated from its hinterland by a range of limestone, and the plateau is about 270 feet above sea level. Two parallel pipelines extend 600 miles from Baku to connect the oilfields with the export terminal at Batum, on the Black Sea, and run along the main railway line which is used chiefly for oil transport.

GROZNY oilfield is in the central part of Circassia, north of the main Caucasus mountain range. In ancient times, this territory linked the Mediterranean civilizations with the Orient. Trading posts were established by colonies of Tartars, Mongols, and Russians who were attracted by the geographical location and the fertility of the plains. Output of the oilfield is about 45,000 barrels daily, or 7 per cent of the entire Soviet output. The main oil port on the Black Sea is Tuapse, and on the Caspian Sea, Makhach-Kala (formerly known as Petrovsk).

Grozny is connected to Makhach-Kala by two 96-mile pipelines, and to Tuapse by a 372-mile crude line, while shorter lines run from Molgabeck 72 miles to Grozny and from Gorski Mountain 35 miles to Grozny. There also is a 295-mile pipe connection for refined products extending from Grozny through Armavir and Rostov to Nikilovka in the Ukraine, while there are several railroad connections to these and other points in the Caucasus.

Third largest oilfield in the U.S.S.R. is Maikop, which has an output of some 38,000 barrels daily or 5 per cent of the total production. Although lack of roads and uncertainty as to its importance at first retarded the development of Maikop,

*Formerly assistant managing editor, *World Petroleum*; assistant editor, *Petroleum Times* (London); British correspondent, *La Revue Petrolifere* (Paris). Now with the U. S. Army Air Forces.

it rapidly has been overtaking and is planned to succeed the older field of Grozny. Maikop is in the Kuban province of Circassia, and is bounded on the south by the main Caucasus range, on the east by Daghestan, and on the west by the Black Sea. It is connected by railroad to Armavir and Tuapse, while pipeline facilities include a connection with the Grozny-Tuapse trunk line, a 60-mile line to Krasnodar, and smaller lines to Kutais, Asphalt Mountain, etc.

Lesser oilfield developments in the Caucasus include Daghestan, Kuban-Black Sea, and Georgia, of which the first-named is the only one of present importance. Its oil output is but a negligible proportion of the national production. This area is in Circassia and is bounded by the Caucasus range on the south, Grozny on the west, and by the Caspian Sea on the east. The Georgian Republic is bounded on the west by the Black Sea, on the south by Turkey, on the south-east by Azerbaijan, and on the north by the Caucasus Mountains which are a part of it.

Crude oil from the Caucasus oilfields and others around the Caspian is processed in refineries distributed over approximately the same general area—Baku, Grozny, Makhach-Kala, Krasnodar, Tuapse, and Batum. They are capable of treating about 850,000 barrels of crude daily (greater than the actual output of the region), and represent some 85 per cent of Soviet refining capacity.

BUT where are Russia's chief sources of petroleum outside the Caucasus? There is some small production on Sakhalin Island, off the coast of eastern Siberia, but this is required for the military and naval forces based at Vladivostok to prevent an attack from the rear by Japan. It may not even be adequate for that purpose. Even were the output much greater in that region, oil cannot be brought into European Russia from Eastern Siberia in any great quantities through this back door because of the limitations imposed by the single-track trans-Siberian railway system.

There are also small oilfields in the Turkmen provinces. On the eastern shores of the Caspian Sea, minor oil deposits have been developed in Chikishliar, in the Ferghana Valley at Neftdag, and on Cheleken Island. These, together with those in the Samarkand, are served by the port of Krasnovodsk. Further to the east are the oilfields of Utchkizil, Kaudag, Haudag, Shirabad, and Neftbad. This whole area lies in central Asia, bounded on the south by Iran and Afghanistan, on the east by India and the Sinkiang Province of China, on the west by the Caspian Sea, and is separated from the rest of Siberia by the natural boundaries of the Aral Sea and the Altai Mountains. Operations in this region have been impeded by the sandy desert terrain, lack of roads, and poor vegetation.

The only other oil region, next in importance to the Caucasus, is the area known as the Eastern Oil Base, comprising the Emba district and Bashkiria in the Ural-Volga district. Great stimulus has been given to these operations, which represent the bulk of oil production outside the three main fields. Value of the area has long been recognized, but its development has been retarded by geographical isolation and adverse climatic conditions. Emba is bounded on the north by the Actiubinsk region, on the east by the Ust-Urt plateau, on the south by the Caspian Sea, and on the west by the Ural River. Development was made possible only by construction of a pipeline from Guriev to Orsk, and Emba normally is reached only during the short summer season, although a railroad extending from Samara to Tashkent, via Orenburg, cuts through this area and provides a means of access to the fields. In addition, some pipelines connect Koschagil and Makat Dossor fields to Guriev, while a new railway line is believed to have been built from Guriev to Kandagash. Value of the region lies in the extent of its reserves rather than in current production.

The Ural-Volga portion of the Eastern Oil Base is situated in eastern Soviet Russia north of Emba, northwest of the Ural River. Production here also has been increasing at a rapid rate during recent years in the attempt to decentralize oil output, and the Ishembayevo oilfields are connected by a 91-mile line to Ufa refinery; other oil transportation in the district is by rail. While progress has been considerable, it is believed that oil production has not reached the desired proportion of national requirements.

Here, indeed, is a vital point in the Russian armor which Germany might easily consider worthy of the greatest possible military concentration—seize the Caucasus, knock the Soviet Army out in another year or two of warfare, and then turn about to face the remaining forces of the United Nations without fear of disaster on the Eastern Front.

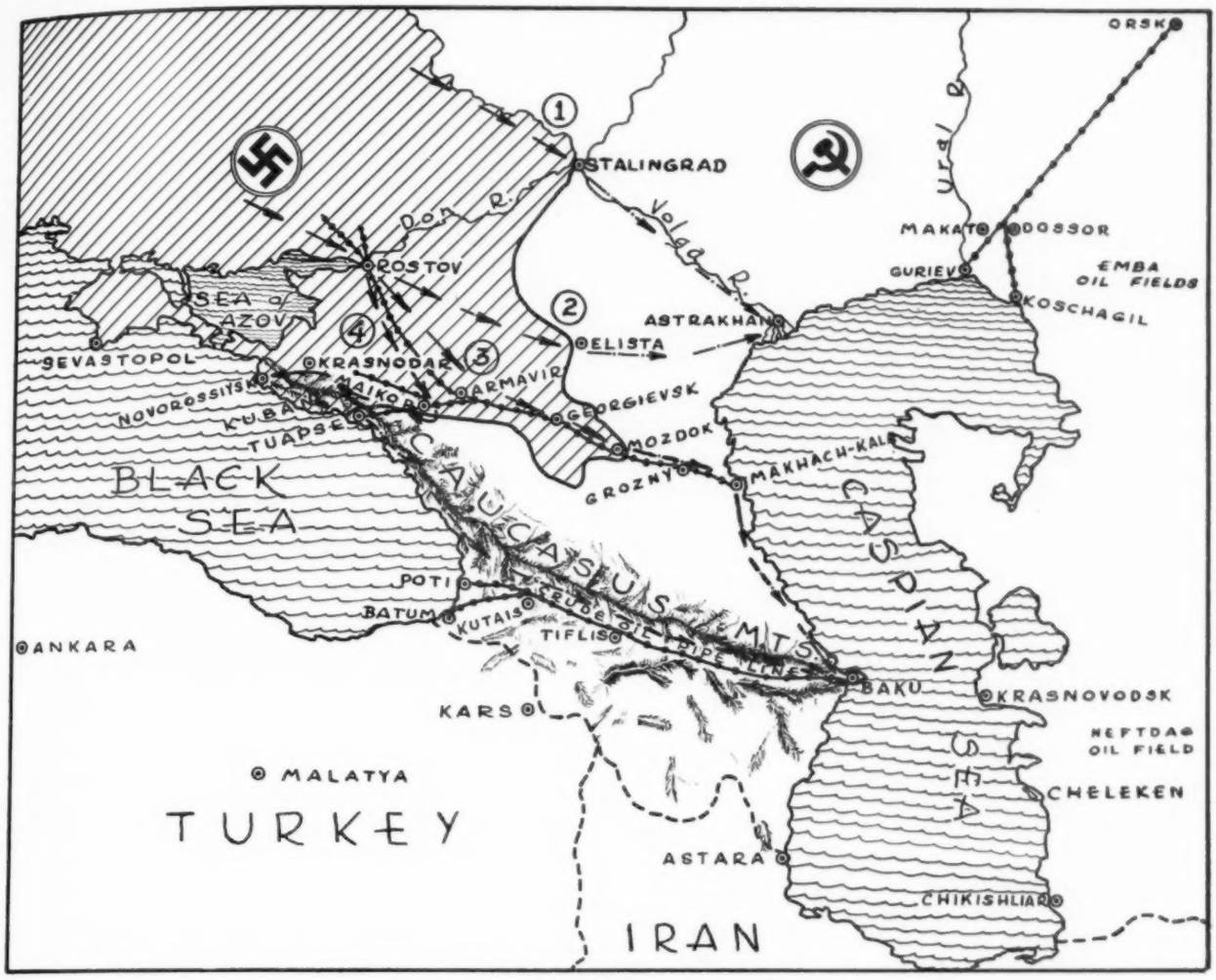
Despite desperate resistance on the part of the Soviet forces, the Nazi pincers had begun to close with intensified fierceness on the great Caucasian stronghold. That the terrain made some parts of the attack exceedingly difficult to prosecute was a help to the defenders—but German mechanized forces succeeded in crossing the so-called impassable slopes of the Balkan mountain ranges, and they are not likely to hesitate at the mountains and arid steppes of the Caucasian chain. Indications are that they will gratefully accept the inviting approaches afforded by the oil pipeline routes, railroads, and perhaps even the three military roads built across the Caucasus range as a defense measure by the Russians.

THE most powerful jaw of the German pincers drive is the thrust along the huge pipeline extending from Makhach-Kala to Nikilovka. By mid-June, Germany's 1942 *Drang Nach Osten* was coiling up for what the Nazi high command probably hoped would be the death blow. A month later, one jaw of the pincers was reaching downstream along the Don River to Migulinskaya, another pushed past Voroshilovgrad, while further to the south Nazi troops had reached the Nikilovka terminus of the pipeline.

At this point the drive gained momentum until, by mid-August, thrust No. 1 along the Don was at Kachalinsk, on the outskirts of Stalingrad; thrust No. 2 had reached Elista; and thrust No. 3 had accelerated at a terrific pace along the route of the oil line, piercing the Russian defenses right through Rostov and Armavir and on to the lesser oil area in the region of Mineralnye Vody, Georgievsk and Pyatigorsk. In addition, what may possibly be the beginning of thrust No. 4 lopped off the oilfield of Maikop, third largest in the U.S.S.R., and struck out for Krasnodar and the Black Sea coast.

From this picture we can see the possible development of two alternative pincers movements, success of either of which could cut the greater part of Russia from its main oil supplies. The more likely of the two would be a continuation of thrust No. 2 aimed at the strategic Volga River delta, where at Astrakhan begins a vast network of rivers and canals bearing most of European Russia's inland waterways oil traffic. This might be supplemented by a continuation of thrust No. 1 through Stalingrad.

The southerly jaw of the pincers would grip the oilfields



THE CAUCASUS—OIL CENTER OF SOVIET RUSSIA

Shown on the map are the pipelines from Baku to Batum and from Makhach-Kala and Grozny to Tuapse and Rostov. The cross-hatched area indicates the German advance up to November 8, 1942, while the broken arrows show possible continuations of four German thrusts at the Caucasian oil centers. There are also lesser oil deposits at Neftdag and Cheleken Island on the eastern shores of the Caspian and in the Emba district.

themselves, with thrust No. 3 proceeding along the pipeline on the northern flank of the mountain range through Grozny and on to Makhach-Kala, then southward through Daghestan along the coast of the Caspian and on to the Apsheron Peninsula.

The alternative to the foregoing would be a combination of thrusts No. 1 and No. 2 aimed at Astrakhan, with thrust No. 3 meeting a roundabout continuation of thrust No. 4 at Baku. In such an event, thrust No. 4 would first cut westward to the Black Sea at Tuapse, swing down the coast line to the railhead at Poti or the adjacent oil terminus at Batum, and then forge in through the mountains across the heart of the Caucasus to Baku. However, physiography and climatic conditions of this part of the Caucasus would render this a most difficult advance, and at this stage it seems somewhat unlikely unless as a follow-up drive.

In the case of thrust No. 3, German motorized infantry is already at Elista at time of writing, and has only another 175 miles between it and Astrakhan to the northeast, while it is but 135 miles from the Caspian itself. The other wedge in the vicinity of Georgievsk also is very menacing. Thus far, the Soviet forces have avoided being squeezed by the pincers but only at the cost of a vast territory, and if the withdrawal is continued it will open up to the enemy a clear way to the sea. Strategically, the Nazis would gain a tremendous military advantage by cutting through to the Caspian, even at the cost of withdrawing a considerable portion of the forces attacking Stalingrad.

SHOULD the Russians lose Stalingrad, a few important oil routes would remain. Following possible loss of the Rostov pipeline and the intermediate railroads, Soviet armies to the north and oil-consuming war industries in the interior of the U.S.S.R. would be fed by tankers skirting the western shores of the Caspian Sea from Baku, and skirting the eastern shores from Krasnovodsk, to the Volga delta. From Astrakhan, shipment would be made over a railway leading northward and in part paralleling the Volga. Other tankers might steam directly across to Guriev, 180 miles to the east of the delta, whence a pipeline extends to the large refinery at Orsk, as mentioned above.

More is to be gained by the Germans, therefore, by the immediate occupation of Astrakhan. Firmly established at the delta, the Nazi ground forces would not only cut off all Volga River shipments and adjacent oil traffic, but the air arm should be able to bombard Guriev, at the northeastern end

of the Caspian, into a state of uselessness as an oil terminus.

In addition, the Axis thrust for Grozny and Makhach-Kala bodes dire results for the Russians, and the possible penetration to the Caspian Sea at this point would be about as equally effective as the capture of Astrakhan or even Baku. Entrenched at either of these points, the Germans would have accomplished much more than cutting off Russia from over eighty per cent of its oil supply. In one of the most far-reaching developments since their original attack on Russia, they would have severed the fighting U.S.S.R. in twain and also dammed a substantial flow of American and British war matériel to the larger portion of the Red armies—for a considerable quantity of armaments has been moved from the Persian Gulf by road and rail through Iran, over the Caspian Sea, and up the Volga river-canal network.

But any attempt to push through with these strategically planned thrusts will undoubtedly be countered by fierce opposition, not only by the Red forces themselves but also by the numerous obstacles and hindrances imposed by Mother Nature herself. Let us consider just what would logically face the advancing Germans on their way to the Caspian and Caucasian oil.

In the case of thrust No. 1, the greatest difficulty in the way of the Nazis would seem to be the apparent concentration of Soviet forces at Stalingrad. Once past that city, as also in the case of potential thrust No. 2, the going would be rather easy in comparison with the other roads to conquest. The northern and greater part of Circassia comprises fertile plains, while a large proportion of the steppe lands is treeless, except near streams. The Don Valley has a considerable variety of trees and vegetation, a fairly high rate of rainfall, and about 275 warm and sunny days during the year. This prolonged period of favorable weather should greatly facilitate the German advances.

LET us now consider the nature of the terrain in the southwest, where an attempt to carry on potential thrust No. 4 to the Caspian was considered by the writer as being somewhat unlikely except as a follow-up of prior capture or siege of Baku. Nazi forces already have captured Maikop, thus depriving the Russians of some five per cent of their total oil production. This immediate region consists of forest lands with steppes along the edges of the mountain range. The summers here are warm and the winters quite mild. Further to the westward, on the route apparently being pursued, lies the Kuban-Black Sea oil area which is rather roadless and inaccessible.

Should it be pursued to the suggested possible conclusion, thrust No. 4 might cut westward to the Black Sea at Tuapse, or even make a direct attack on the near-by naval base at Novorossiysk. It would then swing down the coast to the railhead at Poti, near Batum, and then cut inland and across through the heart of the Caucasus Mountains. However, the route along the shores of the Black Sea is very narrow, as the mountains slope sharply toward the coast. This would expose the advancing Nazi forces to direct attack by the guns of the Red Navy. The Soviet Black Sea fleet recently based its future operations at Batum, where there is a 100,000-barrel refinery, and adequate fuel supplies would be available to the end. Oil from this final stronghold would continue to be available to the Red armies fighting in defense of the Caucasus and continually striking from the interior at this German advance.

Even granting that the Axis troops succeeded in pushing back all opposition as far as Batum, the going still would not be easy—far from it. Consider the terrain: The Transcaucasus province consists of barren wastes, the formation of sulphurous gases undoubtedly having contributed to the desolate and desertlike appearance of the region. It is almost uninhabitable due to lack of water and vegetation, and consequently there are no shade trees to give protection from the intense summer heat. The atmosphere is oppressive, occasionally relieved by winds which in turn bring about dust storms. Likewise, the adjacent Georgian Province consists mainly of mountains and plateaus of forbidding nature.

The mountain passes just to the south of the main Caucasian chain are fairly well defined by the joint route of the railroad and the dual oil pipeline, but considerable difficulty may be anticipated by any enemy attempt to storm the defenses. There are but a few primitive roads connecting the infrequent settlements, and these are over calcareous ground cut by boggy ravines. Long stretches along the Transcaucasus Railroad leading up to Tiflis are denuded of any alluvial soil and devoid of vegetation. Furthermore, the way is tortuous and lends itself to defensive warfare, while the Soviet forces presumably would demolish the various mountain tunnels—unless these were first captured by a German surprise attack by parachute troops. On the other hand, the snow-clad slopes of the greater elevations where these tunnels are situated are not encouraging for aërial operations by pilots not familiar with the peculiarities of the region. Once at the midway point of Tiflis, the going would be somewhat easier but still subject to appreciable disorganization by guerrilla tactics from the mountain heights.

Continuation of thrust No. 3 through Grozny would be a relatively simple task. The southern part of Circassia consists of foothills of the Caucasus range. Volcanic evidences are fairly frequent and are noteworthy at Elbrus, with an elevation of 18,526 feet, and Kazbek, elevation 16,546 feet. All large rivers flow from the central part of the Caucasus range, and an appreciable number of them are torrential—which would render the going hazardous for armored forces during the rainy season or with the melting of winter snows. The valleys running crosswise to the projected route of thrust No. 3 might mean virtually a pitched battle for every successive advance. The mountainous stretches of the railroads, including the Vladikavkas Railway, are similar in nature to the lines in the Transcaucasus.

Beyond Grozny, conditions would be much the same in most respects—worse in others. This region consists mostly of sandy steppes with but few roads and communication facilities. Rainfall is more frequent than on the Apsheron Peninsula and there is a richer vegetation along the watersheds, but dampness and heat make it exceedingly unpleasant and oppressive.

EVEN with her fighting forces split in two by a successful German pincers attack on the entire Caucasus oil region, Russia would be able to carry on the fight—albeit greatly handicapped. The rugged Caucasus Mountains, reaching from the Black Sea to the shores of the Caspian, are a formidable snow-clad barrier holding back the hordes of the swastika from complete control of the great producing and refining center at Baku. Just as long as the Soviet can retain some measure of control over production and refining facilities she will be able to provide the vital fuel supplies for her fighters in the mountains who would constantly harass the invaders. In addition to Caucasus oil, Soviet grand strategy

A SECTION OF THE RICH RUSSIAN OILFIELD AT BAKU

has for a decade or so included the establishment of its Eastern Oil Base in the Urals where development of the oilfields has been intensified and refining facilities established far from present threat of attack. These oilfields in the Ural Basin may have even reached a state of exploitation where they are capable of producing about a fifth of the total Russian output—or over 100,000 barrels a day.

While this is not of the relative magnitude requisite to support in entirety the exhaustive fuel requirements of fighting Russia, the Soviet is understood in addition to have been storing as much petroleum as possible at strategic points in the interior. With drastic elimination of all unessential uses—comparatively few in the U.S.S.R.—curtailment of consumption even where ordinarily necessary, and draining of reserves in storage, the Red armies in the north and the Soviet war industries in central Russia might be able to survive on a rather severely reduced scale even if the Caucasian oilfields and the Caspian Sea routes from the fields in Iran and the Turkmen should be lost.

Whether the Nazi forces could seize the Caucasian oilfields intact is highly questionable. The Soviet claims to have thoroughly demolished the Maikop field before abandoning it in the face of the fierce German onslaught and undoubtedly would likewise employ oilfield demolition tactics if forced to give up any other producing areas. Just how efficient the Reds might be in this regard is another matter. The Russians could do serious surface damage with comparatively little effort, but it likewise is essential that the wells be thoroughly demolished below the surface. Official Soviet communiqués in this connection merely claim the removal from Maikop oilfield of all portable equipment and stored petroleum and state that the wells had been made "completely unusable" before seizure by the Germans. How much destruction was wrought below the surface is not made clear. If a good job has been done, the field may be valueless to the invaders for at least half a year, and possibly twelve months or more, depending upon the availability of exploitation equipment from Germany or Rumania.

IT undoubtedly would take many months to rehabilitate temporarily despoiled oilfields, if and when others are captured. Valuable as Caucasus oil would be, however, its gain is not the immediate and urgent objective of Nazi strategy. Rather, the real purpose is to jeopardize Russia's war effort through loss of her chief oil region and principal communications line with the United Nations. Should even a partial paralysis of the Red armies be achieved, it would be an important victory for Berlin.

If Germany succeeds in overrunning the Caucasus, she would be in a position to thoroughly demolish the oilfields herself and render the area equally valueless to the Soviet should she be forced to withdraw later. The other side of the picture of a German success is a potential gain for the Nazis of an oil territory now producing around 523,000 barrels daily and capable of even greater output.

Once established in the industrial areas of Stalingrad and the Donetz Basin, as well as in the oilfields of the Caucasus, Germany would have a new center from which to strike. Again, as when she took over Rumania and the Balkans, the Nazis would have shortened their immediate communication lines even as their effectiveness was extended, and they would be in a strong position to attack the remaining Russian armies from the south, Suez from the northeast, or Iran and India from the northwest. A glance at a global map will quickly bring the realization that in such an event it would not be unreasonable to anticipate a joint attack on British India in a gigantic pincers movement by Germany and Japan.

EDITOR'S NOTE.—This article was written before the Russian counterattack in the Stalingrad area. While the tactical situation has altered, Nazi grand strategy in the Caucasus as outlined herein is probably still unchanged.

Maintenance Regiments

The Automotive Industry Recruits Affiliated Ordnance Units

Col. C. Wingate Reed*

THE mission of the Ordnance Department has always been the development, production, and maintenance of the fighting equipment of the Army. In the days of the foot soldier, this was a comparatively simple proposition. Most of the maintenance was done at Ordnance arsenals or depots. Only a few companies were required for maintenance work in the field.

World War I brought a new conception of warfare, predicated upon the automotive principle. This had its inception in the tank and the airplane, two vehicles dependent upon the gasoline engine. Later, the ponderous, slow-moving tank was redesigned for greater speed. Then followed in quick succession high-speed artillery carriages, self-propelled artillery mounts, and half-track armored cars. Finally, entire organizations were put on wheels. Today, foot power has been changed to engine power—the modern mechanized division has a total of thirty-two horsepower per soldier. This calls for motor maintenance in a big way.

Early in the present conflict, the entire automotive industry was converted overnight from automobiles for pleasure to automotive vehicles for war. The principal component of each is an internal-combustion engine. This engine is a marvel of mechanical power but a glutton for maintenance. For this reason the automotive industry of peace time had three principal phases—design, production, and maintenance—and these same three phases also characterize modern mechanized warfare. Thousands of maintenance organizations, ranging from elaborately equipped plants to road-side garages, existed for the servicing of America's peace-time pleasure and commercial vehicles. Only a limited number of trained mechanics were available in the rapidly expanding Army, which has the greatest quantity of mechanized matériel in all its history. Furthermore, this Army and its equipment is being sent into distant theaters of operation, many of them halfway around the globe, with no arsenals or depots to depend upon. It was obvious, therefore, that base shops, mobile machine shops, recovery, repair, and wrecking trucks be procured and manned to meet the demand for maintenance.

At the beginning, time was short, and the magnitude of the maintenance problem of the present war was quickly apparent. Its size can be gauged from the fact that over 100,000 specialists, men already trained and experienced in more than 50 trades, were required. It was evident that the overtaxed Selective Service procedure would be totally inadequate to assemble such a vast organization of trained men in the brief period required. Whereas in previous wars, Ordnance companies were sufficient, entire regiments were now necessary.

The solution was the Affiliated Ordnance Unit. These units are composed of trained and experienced men, recruited directly from civil life for a particular job. The War Department therefore directed the Chief of Ordnance to arrange for the affiliation of the necessary Ordnance units composed of men from suitable commercial organizations. The success of this campaign was beyond all anticipation. Realizing that a large portion of the mechanics in the country were in the automotive industry, with which the Ordnance Department was in close contact, it was to them the problem was taken. America had solved its automobile-maintenance problem by setting up a far-flung and closely woven web of garages and service stations. Most of these belonged to, or could be reached through, the National Automobile Dealers Association which had operating branches in every state. Therefore, the coöperation of this organization was first enlisted, and a vast campaign, directed to the mechanics of the country, was quickly set in motion. Thus the burden of recruiting was thrown squarely on the shoulders of patriotic civilians, and they came through in a most satisfactory manner.

THE first two Ordnance units to be raised through affiliation with industry were the 301st and 302nd Ordnance Regiments. Cols. D. C. Cabell and W. B. Slaughter were selected to recruit and command the two organizations. They made a whirlwind tour of the country by plane and rail, laying the groundwork. The situation was explained to the national officers of the N. A. D. Association and through them to the various state organizations. A campaign was put in motion that included publicity and advertising through the press, radio, magazines, posters, letters, and other media. State and other local committees were formed, chairmen were appointed, and meetings were held all over the country. Every state in the Union was apportioned into recruiting areas—a unit to be raised in each area. Other public-spirited Americans took up the campaign, and it quickly spread to other industries. Time, effort, and funds were willingly contributed.

The first recruiting of Ordnance Affiliated Units began in March 1942, and in a few weeks the first regiment had more than its quota. By May 1, 1942, the 301st Ordnance Regiment, well over strength, was at Camp Sutton, N. C. It was joined shortly thereafter by the 302nd. Here the trials and tribulations encountered in a new undertaking quickly developed. However, through the able leadership of the officers of the organizations, the zeal and patriotism of the enlisted personnel, and the coöperation of the National Automobile Dealers Association, the mistakes made in the early recruiting of these organizations were remedied and the procedure for future procurement developed.

Under the present plan for recruiting Affiliated Units, the sponsor advises the Chief of Ordnance of the size and type of unit he can raise. He sets the date when his applicants can be assembled and interviewed. Trained recruiting officers are then sent out by the Chief of Ordnance. These officers are equipped with manning charts and tables of organization for the particular type of unit they are to procure.

All candidates for officers are interviewed by the Affiliated Sponsor Committee which does not limit consideration to its own members—a justifiable qualification for the job at hand is the only requisite. The candidates' qualifications are carefully studied by the Affiliated Nominating Committee, and those selected are then interviewed and accepted or rejected by an Ordnance officer.

*Chief, Military Personnel Branch, Office of the Chief of Ordnance. Colonel, Ordnance Department, U. S. Army.

MODERN WARFARE DEMANDS MANY ORDNANCE MECHANICS TO MAINTAIN THE ARMY'S MOTORIZED EQUIPMENT

The names and records of candidates selected for commissions are given to the officer-procurement service of the interested service command. This organization obtains all necessary data on the candidate, including his physical condition, and forwards it to The Adjutant General of the Army. Candidates for the enlisted grades are processed through the local recruiting service for enlistment in the Ordnance Enlisted Reserve and are assigned to the specific maintenance organization being formed in that locality. When the organization is completed, it is called to active duty on a specified date. It is planned to induct the officers first and have them trained by the time each organization is completed and called to duty, but the time factor does not always make adherence to this rule possible.

The newly enlisted men return to their homes subject to call, but the officers are ordered to the Ordnance School for training. On a designated day, an order is issued by The Adjutant General calling the unit to active duty. This call is sent through the appropriate service command to the enlisted personnel. These men are sent to a reception center for induction into the service and receive their initial equipment. They are then sent to the station designated as the place of training for the unit. In the meantime, the officers of the unit are ordered from school to the place of activation so they will arrive prior to the troops.

THE Army's need for trained technical personnel was brought home to industry so vividly that individual manufacturing concerns were imbued with the spirit and contributed in a most substantial way. The International Harvester Company recruited two battalions and is now raising several companies. The John Deere Company recruited one battalion from the personnel of its own organization. The J. I. Case Company and the Allis-Chalmers Manufacturing Company each contributed a company. One of the first organizations to volunteer assistance in this work was the American Road Builders Association. This organization, with the coöperation of the highway departments of many states, has furnished trained personnel for a number of maintenance companies. Thanks to the untiring efforts of the officials of the organizations with which the Ordnance Department is affiliated in this movement, the Army now has thousands of highly trained and experienced mechanics for its maintenance work and is rapidly procuring more.

Affiliated Ordnance regiments will establish base shops for the complete overhaul of all types of ordnance equipment. Machinists, toolmakers, watchmakers, and other skilled artisans have been quickly taught the intricacies of recoil mechanisms, automotive weapons, and fire-control equipment. Ordnance maintenance battalions are assigned to Armored Force divisions and are available for the immediate repair of their equipment. Medium- and heavy-maintenance companies support army corps and Armored Force troops with still more elaborate maintenance facilities. Depot companies, recruited from the spare-parts branch of the automobile industry, are available to establish depots and keep the ever-necessary supply of parts flowing.

These Ordnance maintenance regiments, supplemented with battalions and companies, constitute a balanced organization of specialists equipped to service and repair everything used by a modern mechanized army from a tank to a delicate fire-control instrument. When an American task force goes into action on any front, it now can be certain its matériel will be properly maintained. Mechanics and specialists with adequate tools, the "know-how," and the spirit, will return disabled matériel to the fight in short order.

Protection against Sabotage

A Discussion of Warning Devices To Guard Industrial Fence Lines

R. W. Reynolds*

PROTECTION against saboteurs is a serious problem today. Whether a plant or a military establishment is concerned, no amount of human vigilance can be considered extravagant. Supplementary to sentries or guards are certain scientific devices which may be adapted to increase the degree of protection. These—and in particular a specially developed system known as the "acoustic fence"—are discussed in the following article.

A typical plant usually consists of a building or a group of buildings inclosed within a fence and including some open space between the fence and the buildings. The first line of protection is usually the fence itself, and a great part of the money and effort devoted to protection is for the purpose of preventing illegal or unauthorized entry inside the fence.

In actual practice, the fence is usually lighted and kept under observation by fixed guards or road patrols. This general system of protection may fail when lights are extinguished for blackout purposes, when bad weather such as fog, rain, or snow interferes with vision, or when guards are inattentive or absent from their posts.

For these reasons it is highly desirable to apply a supplementary device which will give a definite alarm when an attempt is made to pass under, through, or over the fence, thus drawing attention.

The pressing demand for war-time protection of fence lines to prevent saboteurs gaining entry to vital plants has been met in part by adaptations of the following systems, all of which were primarily designed for other purposes: (1) Photo-electric devices utilizing fixed beams of light (visible or invisible) with arrangements for sounding an alarm when the beam of light is interrupted; (2) Balanced-capacitance systems in which the fence, building, or other structure to be protected is utilized as one plate of a condenser and an alarm sounds when this capacitance is altered by some foreign object coming in contact with or in close proximity to the fence or structure under protection; (3) Numerous burglar-alarm systems which react to the movement of some member (such as a door or window sash) in the protected structure; (4) Lethal schemes which involve some arrangement whereby an intruder would be electrocuted, asphyxiated, or shot upon coming in contact with or disturbing a member of the protected structure; (5) Public address systems used as a protective device or in conjunction with some other protective scheme; (6) Various systems of radio communication; (7) Silhouette lighting and similar means for observing intruders.

In considering the application of these classes of devices for alarm or detection purposes in connection with a fence line, it became apparent that numerous difficulties were involved. Photo-electric devices consist of a lamp and lens for projecting a beam of visible or invisible light along a straight line to a photo-electric cell responsive to the intensity of the light. As long as light of a given amount or intensity impinges on the cell it generates a current which, by means of a system of amplifiers and relays, holds an alarm circuit inactive. If the beam of light is interrupted, the cell stops generating, and the alarm goes into action.

The limitations of this system are considerable. The maximum length of the beam of light is limited to about 500 feet—preferably 300 feet if it is to function outdoors during inclement weather. The fence around ordnance plants may be from five to twenty miles in length, and consequently a large number of beams and a large amount of equipment would be required. Terrain may be such that it is very difficult to carry the beams of light close enough to the ground to prevent an intruder from crawling underneath them. Fog, snow, or snowdrifts may cause considerable difficulty by giving false alarms, particularly if long beams of light are used.

Heavy foundations are required for both the light source and the photo cell to prevent disturbances of the alignment due to ground settling or impact against the supporting standard. The cells are mounted in a heavy metal housing which absorbs heat from the sun when used outdoors—and photo-electric cells become ineffective when the temperature exceeds 120 degrees Fahrenheit. A metal housing exposed to the summer sun will quickly reach such a temperature in many parts of the United States. Properly housed photo cells, can, of course, be built, but they are not always available.

ANOTHER objection to a photo-cell system hinges upon the fact that infra-red flashlights are available; by carrying and using such a flashlight intelligently, an intruder can walk in and out of most beam systems without disturbing the system at all. Tuned intermittent beams overcome this objection, but the time delay associated with such systems detract much from their effectiveness. An object moving with a velocity in excess of ten miles an hour may move through such beams without giving an alarm. No photo-electric system investigated is adapted for direct-current operation from storage batteries, and consequently it is difficult to sustain operation during blackouts when power may be off. Cost is the next greatest objection. The cost of a photo-cell system for general application without redesign to meet special requirements is approximately $2.50 a beam foot or $5 to $10 per foot of fence; two to four beams are necessary to adequately protect an ordinary fence. In the case of a typical large ordnance plant, the application of photo cells to the plant fence would cost approximately $200,000 and possibly more by the time the necessary power supply and signal-transmission system were fully detailed.

The balanced-capacitance system formerly offered by one large manufacturer involved an arrangement whereby the fence was insulated from the ground and used as one plate of a condenser, or auxiliary wires were carried along the fence or adjacent to it, insulated from the ground and used in the same way. An object with capacitance (and this includes almost all objects, particularly human bodies) coming in contact with the fence would alter the capacitance of the con-

*Principal electrical engineer, Design Division, E. I. du Pont de Nemours & Company, Wilmington, Del.

denser. This alteration brought about changes in the minute electrical currents involved which caused the sounding of an alarm.

The cost of this system was approximately $1.70 per foot of fence protected because it was necessary to divide the fence into sections not exceeding 200 feet in length and protect each section separately. When the auxiliary wiring necessary to bring this system under the supervision of a feasible number of guards was taken into consideration, the cost for a large typical plant appeared to be between $150,000 and approximately $200,000.

There are, of course, numerous burglar-alarm systems devised in such a way that they react to disturbances which make or break contacts and respond to any effort to force or break into a building through a door or window, etc. As far as fence protection is concerned, most applications of this type are of a makeshift nature because they are designed primarily for buildings, safes, or similar inclosed structures. When applied to a fence, such systems become very complicated, subject to tampering, and are generally ineffective. None of the systems considered offered any protection whatever against such a contingency as a man digging his way under a fence. One of the first efforts to get into a defense plant was by this means.

CONTROL ROOM FOR THE ACOUSTIC FENCE

Flashing lights show section being tampered with; operator dispatches patrol car to spot.

LETHAL schemes which involve some arrangement whereby gas is released in the vicinity of a disturbance or a machine gun is set in action along a fixed line, are highly undesirable as automatic installations because of the hazard to operating personnel and the public liability involved. The easiest lethal scheme to apply in connection with a fence is to carry high-voltage conductors parallel to the fence either on the inside of the property or along the outside of the fence. At considerable cost, it is possible to insulate the fence itself from the ground and carry it at high electric potential for the purpose of electrocuting intruders at the point of contact.

This system is very deadly and it has great psychological effect. It is not necessarily complete protection because the highest practical voltage for such a fence is about 10,000 volts, and by means of rubber gloves and insulated shoes it is possible to climb through or over a fence carrying twice this voltage. Clearance must be maintained between the electrified fence and the ground, with the result that it becomes very easy to dig under the fence. Such a fence is also dangerous to people approaching it on legitimate business, and it would almost certainly have to be out of service while fence lines were being cleared of weeds. Such systems, of course, have been successfully used, and they offer very good protection against all intruders, except those with technical qualifications. The cost of such a system would depend entirely upon the particular scheme used, but a typical installation would probably cost in the neighborhood of $1.50 per foot of fence, which would amount to $100,000 to $150,000 for a typical large plant. If operating personnel inside the plant were to be protected from the electrified fence by barrier fences, the cost might run considerably higher.

Public address systems may be a part of any protective scheme but they hardly constitute protection in themselves. It is our understanding that one of the better-known penal institutions completely surrounded by water has a system whereby boats approaching the place are warned to change their course by means of loudspeakers located around the water line. In the case of ordnance plants, such an application is unnecessary and would probably be classed as definitely undesirable, because it is nearly as important to apprehend intruders as it is to detect them.

Systems of radio communication between guard headquarters, guard stations, and roving patrols are properly classified as communication facilities rather than as protective devices and may be used in place of or in connection with other communication systems such as telephone, signal lights, audible signals, etc.

Silhouette lighting along a fence is somewhat more expensive than the conventional lighting system and usually has insufficient advantages to justify it. In practice, the closest approach to the ideal for silhouette lighting is a concrete highway where a foreign object can be silhouetted and its shadow thrown upon a virtually clean plane surface. The terrain along a fence is not entirely clean, seldom flat, has no highly reflective surface, and is, in general, not suited for such lighting. At best, any lighting scheme increases visibility but does not offer any positive means of drawing attention when intrusion or disturbance occurs. Some device, even in daylight, is necessary for this purpose.

THERE are many variations within the foregoing general types of systems used individually or in connection with each other, but when specific applications were considered, it seemed that all of the schemes described entailed serious disadvantages. The more feasible types, such as the balanced-capacitance system and the photo-electric system, were exceedingly high in cost, questionable in operation, or subject to defeat in various ways. The type and amount of equipment involved and the possible difficulty of obtaining delivery were also factors. These considerations led to the development of an alarm system, known as the "acoustic fence," considerably different from any of those described above.

This device takes advantage of the fact that most plant fences are of all-metal or substantial wooden construction. If a continuous wire or strong wooden fence is disturbed by impact (even though the impact is exceedingly small) mechanical vibrations will pass from the point of the disturbance and travel along the fence for an indefinite distance. Impact upon the ground in proximity to the fence also will

start vibrations which pass to structural members of the fence and thence along the fence for considerable distances. It is, therefore, possible to place a vibration pick-up (such as the pick-up which rides the record on an ordinary phonograph) against a member of the fence and with suitable amplifying equipment to get audible registration of vibrations set up in the fence at remote points.

This registration can be obtained by means of a loudspeaker or by using the amplifier output to operate a relay, which in turn can be used to sound an alarm or carry a signal to and from central headquarters, or both. The sensitivity of the device is such that it will detect and sound an alarm when a bird lights upon the fence several hundred feet from a pick-up. It will detect an attempt to climb the fence or dig under it for a distance of 1,500 to 2,000 feet from a pick-up, depending upon the construction of the fence. In short, the range and sensitivity are somewhat greater than actually required for normal operation. The device is not appreciably affected by wind, rain, snow, or fog, provided extreme ranges are not used.

Plant Guards Answer an Alarm

Armed patrolmen rush to a waiting car and are soon investigating any disturbance to the plant fence.

In actual practice, especially developed magnetic pick-ups of weatherproof construction are attached to the fence at intervals of 1,000 feet. This results in an operating range of 500 feet on each side of each pick-up, which is about one-third the maximum possible range.

THE conventional crystal-type pick-up is too delicate in structure for an application of this nature, and its temperature limitations render it unsuitable for enclosure in a tamperproof metal housing exposed to sunlight, for deterioration of the crystal begins at approximately 120 degrees Fahrenheit. The magnetic-type pick-up developed is independent of temperature and also has electrical characteristics which make it suitable for installation as far as 2,000 feet from the attendant amplifier. It is this feature which makes it possible to mount the pick-up along the fence between guard towers without the necessity of expensive unattended amplifying equipment in similar locations.

Where guard towers are placed along the fence at intervals of 800 to 3,000 feet, it is only necessary to have pick-ups between guard towers with three wires (approximately 22 gauge) leading from the pick-ups (which are in parallel) to one of the adjacent towers where the circuit is connected to amplifying equipment which provides (1) a loudspeaker which enables the guard to hear and usually identify the nature of the disturbance to the fence; (2) a relay which closes and rings a small bell in the tower and, if desired, transmits a signal to a central headquarters over the telephone system; (3) a pilot light which indicates that the system has been disturbed and must be reset manually.

Thus the system enables the guard to hear any disturbance along the fence, gives a visual indication that a disturbance has occurred, and the alarm bell insures the guard's attention. The sets are extremely flexible as far as the possible arrangements for transmitting and sending the alarms are concerned, and variations may be worked out to suit individual applications. For isolated installations, such as public-utility stations in remote, unattended country locations, the device is offered with attached radio transmitter, which may be worked in connection with a receiving set connected to an automatic signal at some central point.

The acoustic system was first applied at two plants using commercially available units, and as first put into operation consisted only of sound pick-ups, amplifiers, and loudspeakers. The amplifier relay was contemplated but required development work and consequently was omitted pending an actual trial of the fundamental system. The original installations used pick-ups spaced at intervals of 3,000 feet along the fence and commercial amplifiers of approximately 80 D. B. gain. This system was considered satisfactory and was accepted. Data obtained from these installations made it possible to proceed with the development of the more satisfactory type of magnetic pick-up, an amplifier with a gain of 115 D. B., and the amplifier-operated relay originally contemplated. Optimum spacing and arrangement of equipment was determined and other operating problems evaluated and taken care of.

As applied at this time, the performance of the equipment is definitely predictable. It is extremely sensitive, protected from tampering even by the guards themselves, and offers the necessary flexibility to meet the requirements of particular installations. The equipment is simple in operation, involves no exceedingly fine adjustments, is independent of terrain, is easily maintained, is economical to install, and can be delivered within a reasonable time. The over-all cost of the system varies from 40¢ a foot to 75¢ a foot, depending upon the nature and extent of the fence protected.

In addition to fence protection, it is sometimes desirable to provide detectors for individual buildings or spot locations, but it is hardly possible to discuss such applications in general terms. The class of protective equipment to be used and the particular physical and schematic arrangement involved vary a great deal, depending upon the application. The presence of normal traffic, the existing noise level, the proximity of guards, and other factors all must be considered.

Editor's Note.—The devices mentioned here are concerned primarily with the safety of equipment and materials The other phase of industrial safety is the safeguarding of personnel. Col. A. B. Johnson, Safety and Security Branch, Office of the Chief of Ordnance, wrote on this subject in the November-December 1942 issue of Army Ordnance (Vol. XXIII, No. 135, p. 486). "The basic reason for safety is cost in essential man power," he said. "Industrial safety must be conceived of and administered as being concerned with all men and all equipment. Safety is not a part-time job."

Standard Surface Finishes

New Ordnance Inspection Methods Insure Uniform Materiel

Lieut. Col. William J. Darmody*

INSPECTION of ordnance matériel consists of all operations necessary to insure that the requirements of contracts, drawings, and specifications are complied with in production. In performing inspection, certain aids are available and necessary to insure compliance with specifications. Dimensional requirements are expressed in units of measurement, with certain tolerances to permit mass production, and gages are available to insure compliance with these requirements. Physical and chemical requirements are expressed in terms of recognized engineering units, and laboratory facilities provide a check on accuracy.

THE SURFACE FINISH OF A GEAR BLANK IS COMPARED WITH THE INSPECTOR'S SPECIMEN BLOCKS

Ordnance specifications and component drawings outline finish requirements which are indicated by means of symbols placed on lines representing surfaces to which the finish is intended to apply or, for pieces with an over-all finish, by a general symbol under the title for the part. Ordnance finish symbols apply to the finish that results from machining or from other metal-forming operations used to produce components to the dimensional requirements of component drawings. We will not consider here the requirements and aids necessary for the inspection of surfaces with final finishes obtained by chemical and metallurgical methods used to give appearance and corrosion-resisting properties to surfaces that have been previously machined or formed to size. It is the purpose of this article to discuss finish requirements and the aids that are or will be available for determining compliance with finish requirements.

Surface-finish inspection may be divided into three categories based upon the aids that are available for inspection. In the first category are surface defects that can be detected by visual, microscopic, and magnetic methods. This category includes cracks, checks, blowholes, nicks, burrs, corrosion pits, and other surface defects that are easily recognizable and which do not normally result from the cutting, abrading, or forming action of tools. The second category covers that characteristic of surfaces known as waviness. Waviness is a surface configuration which usually results from improper functioning of the cutting, abrading, or forming machine. Waviness usually can be detected with the aid of conventional measuring instruments for the distances between the crests and troughs of the waves as a rule are long enough to permit the contact of a measuring device to follow the outline of the wave. In some cases, waviness results in lobed shapes of constant diameter (isodons) where the waviness cannot be detected with 2-point opposed-contact measuring devices. The inspection of such surfaces requires considerable ingenuity in the use of measuring instruments.

The third category of surface-finish inspection pertains to that characteristic of surfaces known as roughness. Surface roughness includes only the random or recurrent irregularities or scratches that result from the cutting, abrading, or forming action of tools. A profile section through a surface reveals that the irregularities or scratches that form surface roughness consist of a configuration of shallow valleys so closely spaced that the contacts of conventional measuring instruments will not enter them; therefore, since conventional measuring instruments cannot be employed for inspection of surface roughness, it is difficult to specify requirements in terms of recognized engineering units. This phase of surface-finish inspection is of primary importance in a war production program where thousands of inspectors must accept or reject components produced according to component-drawing finish symbols.

CONTROL of surface roughness is necessary to insure proper functioning, increased fatigue strength, and adequate wear life of ordnance matériel. Prior to World War I, the Ordnance Department recognized the importance of controlling surface finish by inaugurating the system of designating required finishes by symbols. Five symbols are used to designate finish requirements on ordnance drawings. These symbols and their meanings are as follows:

f.—Requires the finest grade of machine finish. If the work is such as to demand it, the symbol also includes scraping and draw filing. This finish is generally used for ordinary bearing surfaces.

*Officer in charge of gage design, procurement, and control, Inspection Gage Suboffice, Office of the Chief of Ordnance, Philadelphia, Pa.

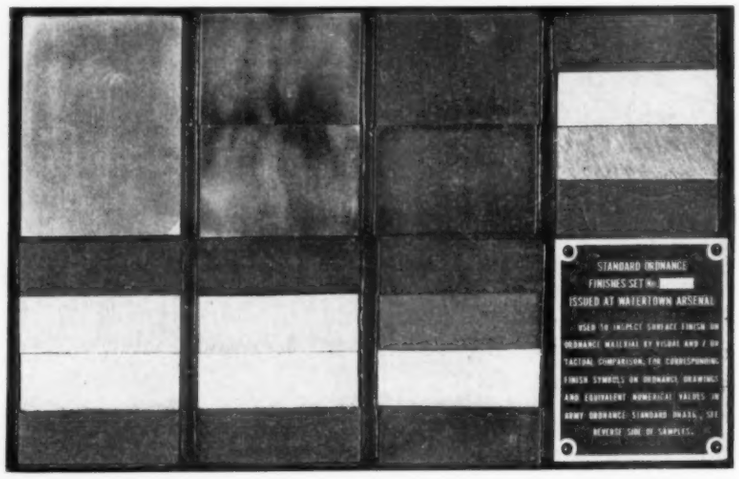
f.—Requires a machine finish of good quality, such as is properly applicable to surfaces fitting together but not moving on each other.

cf.—Requires a coarse machine, chipping, or coarse grind finish and is applicable to clearance cuts or surfaces which are finished to insure the avoidance of interference or of excess metal in walls of castings.

fg.—Requires a fine grind finish for important bearing surfaces and those carrying heavy loads. Such a finish is usually produced by the use of fine abrasive wheels and includes lapping and polishing when necessary.

g.—Requires a coarse grind or file finish for the purpose of smoothing and improving the appearance of an unmachined surface from which no stock is to be removed.

These symbols and their meanings appear in drafting-room regulations and in all the general specifications for ordnance matériel. It should be noted that the meanings of finish symbols are expressed principally in terms of the application of the surface, with reference in some cases to the method of producing the surface.

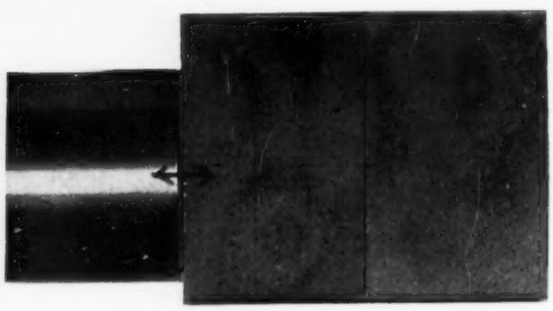


THE STANDARD ORDNANCE FINISHES SET

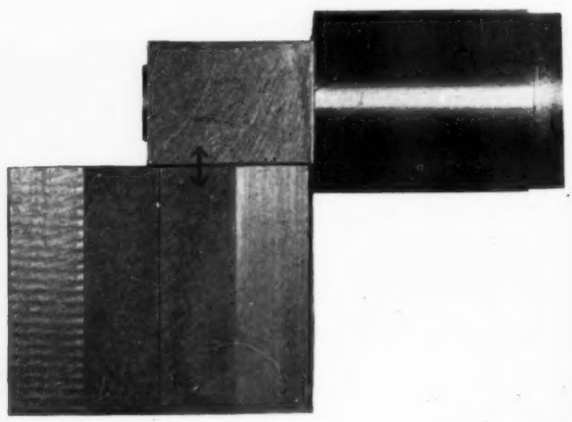
For many years, satisfactory ordnance matériel has been manufactured, inspected, and accepted under the existing Ordnance finish symbols. Experienced designers and the experienced personnel of the manufacturing arsenals had a common conception of what constituted an acceptable degree of surface roughness. In the present production program, with so much matériel being produced by commercial facilities and with thousands of comparatively inexperienced inspectors responsible for its acceptance or rejection, the need soon became evident for a device to be used by inspectors in determining what constituted an acceptable degree of surface roughness under the applicable finish symbol.

In the decade prior to Pearl Harbor, considerable progress was achieved in this country in the development of devices for measuring surface roughness. The principal achievements were in what are known as tracer methods of measuring surface roughness. These methods employ a sharp-pointed diamond tracer which is moved over the surface to be measured, the tracer being mounted so that it can move normal to the surface and thus follow the outline of a profile section over which the instrument is traversed. Electrical circuits actuated by the vertical movement of the tracers are used to amplify and indicate the vertical movement of the tracer points. These devices are known as profilographs, profilometers, and surface analyzers. The industrial use of these devices has led to the development of units of measurement applicable to surface-roughness metrology. The word "microinch," indicating a millionth part of an inch, has become an accepted term applicable to surface-roughness measurement. The electrical characteristics of these devices have led to the adoption of the "root mean square value" of surface roughness, which gives a very good comparison between surfaces of varying degrees of roughness. The root mean square value (rms) is the square root of the mean sum of the averaged squares of the depths of irregularities or scratches traversed by the instrument.

In 1941, a committee composed of representatives of each division of the then Industrial Service of the Ordnance Department was appointed and charged with the responsibility of investigating the problems of surface finish from the standpoint of inspection. This committee was requested to make recommendations for a device to be used by inspectors in determining acceptable surface roughness. At first glance it



INSPECTOR'S BLOCK COMPARED WITH A FINE-GRAIN FINISH



A COARSE-GRAINED PART IS COMPARED WITH THE SPECIMEN FINISH

would appear that the problem assigned this committee was relatively simple because of the availability of American devices for measuring surface roughness. However, the meanings of the Ordnance finish symbols are not expressed in terms of any unit of measurement, so that the use of measuring devices indicating in microinches (rms) was precluded unless the requirements could be changed to this unit of measurement. Changing Ordnance finish symbols to provide the requirements in terms of microinches was further precluded by the necessity for revising thousands of drawings and contracts, the problem of quickly educating thousands of designers and inspectors to a new system, a limited source of supply for available surface-measuring equipment, and by the fact that the use of such instruments had not as yet progressed from the laboratory to the shop.

The surface-finish committee set as its first objective the determination of what degree of roughness constituted acceptable surfaces under the various symbol designations. It soon became evident that a wide divergence of opinion as to what constituted acceptable surfaces under symbol designations existed within the Ordnance Department. The widest divergence was noted between the various classes of ordnance matériel manufacture, although some divergence was noted within classes. For example, the small-arms designer or inspector expected a much smoother finish under an *f* symbol than did an artillery designer or inspector. Another example of divergence within a class of matériel is in artillery where a much rougher finish is acceptable on a 16-inch gun under an *f* designation than would be acceptable under the same designation on a 37-mm. gun. Normally, it would appear obvious that the way to overcome such a situation would be to have a new system of finish symbols providing a wider range of finish designation. However, a change in the system of designating finishes in the midst of a vast manufacturing program would seriously affect production; hence it became evident that the device to be used for surface inspection would have to provide latitude for varying degrees of acceptable surface roughness under the same symbol designation.

Several large American manufacturing facilities have developed sets of specimen blocks finished to represent the roughest surface acceptable under the finish symbols used on their drawings. The committee studying the Ordnance surface-finish problem reviewed several of these commercial devices and found that a set used by the General Electric Company would be well suited for Ordnance inspection purposes. This set provided a series of blocks with surfaces varying in roughness according to the geometrical progression of roughness values established in the American Standards Association's proposed standard (B46) for surface roughness. In using these sets of specimen blocks, the component under inspection is compared to the block which is applicable to the symbol designation for the surface in question. All comparisons are by visual and tactile means, as the human senses of sight and touch are very sensitive indicators of variation in surface roughness.

After tentative selection of the General Electric set of specimen blocks, there remained the problem of fitting the set into the Ordnance symbol designation system and providing for the variation in acceptable roughness under each symbol designation. Reference to the requirements for *cf* and *g* surfaces shows that there is no necessity for control of maximum acceptable roughness; therefore it was not necessary to include blocks for the inspection of *cf* and *g* surfaces. A range of surface roughness from 8 to 250 microinches was sufficient to cover *fg*, *ff*, and *f* symbols, and the only exception to the geometric progression of values in this range was the necessity for a 175-microinch block to provide for inspection of one item of ordnance matériel.

The table (URAX6) shown above, was prepared to provide for the variation in acceptable surface roughness for different types of matériel under a common symbol designation. The sets of specimen blocks described above, together with Table URAX6, will be known as "Ordnance finishes."

STANDARD ORDNANCE FINISHES—URAX6

1. Ordnance finishes are for the use of the inspectors in the acceptance of matériel produced in accordance with the finish symbols shown on Ordnance drawings.
2. Inspection of surface finish will be by visual and/or feel comparison between the Ordnance finishes and the item or component being inspected.
3. Tabulated below are the standards as they apply to present Ordnance symbols and represent the roughest surfaces acceptable under each finish classification for the particular matériel designated herein.
4. The numerical values shown opposite the finish symbols herein are the root mean square (rms) roughness values in microinches.
5. For description of finishes governed by this standard, refer to the applicable general specifications for the ordnance matériel under inspection.

MATÉRIEL	*f* 250	*f* 175	*f* 125	*f* 63	*ff* 63	*ff* 32	*ff* 16	*fg* 16	*Lap* 8
Artillery Carriages & Cannon									
f finish for nonmating parts	X								
f finish for mating parts			X						
Other finishes						X		X	X
Fire Control			X			X		X	X
Small Arms				X		X		X	X
Tank & Combat Vehicles			X			X		X	X
For bearings							X		
Artillery Ammunition									
Shell, steel, Spec. 50-30-1	X				X				
Shell, steel, Spec. 50-30-4			X		X				
Shot, A.P.& Semi-A.P., maj. cal.	X				X				
Shot, A.P.& Semi-A.P., incl. 3"		X			X				
Shell, smoothbore mortar	X					X			
Cartridge cases, primers, boosters, bursters, fuzes, pyrotechnics, grenades, and mines				X		X		X	X

VARIATION IN ACCEPTABLE SURFACE ROUGHNESS FOR DIFFERENT TYPES OF MATÉRIEL UNDER A COMMON SYMBOL DESIGNATION

ARMY ORDNANCE

Founded 1920

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

Col. J. L. Walsh, Founder and Editor, 1920-1922
Brig. Gen. R. H. Somers, Editor, 1922-1925
Maj. Gen. R. L. Maxwell, Editor, 1925-1926
Col. C. R. Baxter, Editor, 1926-1929
Lieut. Col. L. A. Codd, Editor, 1929-1942

Editor: Brig. Gen. R. H. Somers, U. S. Army, Ret.
Associate Editor: R. E. Lewis, Jr.
Editorial Staff: F. G. Ferriter, F. W. F. Gleason, N. A. Woodhouse, M. E. Ferriter, J. C. Dunbar.

The views and statements expressed in the articles and advertisements in ARMY ORDNANCE *are those of the authors and advertisers only and do not represent official War Department policy.*

JANUARY-FEBRUARY, 1943

Month by Month

Americans Land in Africa.—In order to forestall an invasion of Africa by Germany and Italy which, if successful, would constitute a direct threat to America across the comparatively narrow sea from western Africa, a powerful American force equipped with adequate weapons of modern warfare and under American command landed on the Mediterranean and Atlantic coasts of the French colonies in Africa on November 7th, Washington time.

The landing of this American army was assisted by the British Navy and air forces and has been reënforced by a considerable number of divisions of the British Army.

This combined allied force, under American command, in conjunction with the British campaign in Egypt is designed to prevent an occupation by the Axis armies of any part of northern or western Africa and to deny to the aggressor nations a starting point from which to launch an attack against the Atlantic coast of the Americas. In addition, it provides an effective second-front assistance to Russia.

The following American officers conducted these important operations in North Africa: Lieut. Gen. Dwight D. Eisenhower, commander in chief; Maj. Gen. Mark W. Clark, deputy commander in chief; Rear Adm. H. K. Hewitt, U. S. naval commander; Maj. Gen. George S. Patton, commander of American forces landing on the west coast of Africa; Maj. Gen. Lloyd R. Fredenhall, commander of American forces landing at Oran; Maj. Gen. Charles W. Ryder, commander of American forces landing at Algiers; Brig. Gen. James H. Doolittle, commanding our air forces.

The allies were not there with "too little, too late" in North Africa. What Mr. Churchill called "the end of the beginning" amazed the world as much by its perfect timing as by the sensational results. But the phenomenal advance from both ends of the southern Mediterranean shore by British, American, and allied forces was the end product of many long months of planning and preparation.

Lend-Lease in the Desert.—A good part of the allied achievement was due to the volume of Lend-Lease supplies that reached Egypt in the preceding nine months. During this period, we shipped to Egypt more than 1,000 planes, many hundreds of tanks—of which more than 500 were mediums—20,000 trucks, and hundreds of pieces of artillery. In the last 19 months, agricultural products exceeding $33,000,000 in value have moved toward Egypt—for the most part, meats and processed foods suitable for military consumption.

Total exports of American munitions and other products to Egypt since the beginning of Lend-Lease (March 1941 through September 1942) amounted to $636,952,000. This includes both Lend-Lease and direct purchase. By types of product the breakdown is as follows:

Ordnance	$130,058,000
Aircraft (not including flyaways)	164,149,000
Tanks	88,239,000
Motor vehicles	73,113,000
Miscellaneous manufactures	74,606,000
Agricultural products	33,687,000
Industrial materials	73,100,000

The President said: "In particular we should be gratified by the performance of American-made tanks."

The victory of the British over Marshal Rommel was not a surprise to informed American military observers. Maj. Gen. C. L. Scott, commanding general of the Armored Force Replacement Training Center, located at Fort Knox, Ky., who has written an eyewitness account of his observations for this issue of ARMY ORDNANCE (see p. 67), not only has been very confident as to the efficacy of our equipment and that of the British in the Middle East, but he predicted in July that the destruction of Rommel's army was possible. At that time, General Scott stated that Rommel was overconfident; that he was in a very vulnerable position on the Alamein line and would have great supply difficulties; that the British were steadily growing in air support and tank strength, could reorganize their army before Rommel could and then launch a well-coördinated attack with all arms—air, artillery, infantry, and armored units; and that the results would be decisive.

On U. S. Battle Fronts.—In the South Pacific, substantial numbers of American air and ground troops under the command of Maj. Gen. Millard F. Harmon are participating in the operations in the Solomon Islands. General Harmon has his headquarters in New Zealand but spends most of his time at his advance base in New Caledonia. We now have Army air and ground troops in New Zealand, New Caledonia, the New Hebrides, and the Fiji Islands.

Army ground and air units moved to Guadalcanal to reënforce the Marines who have been extending their positions on that battle-scarred island. The Army and Navy forces in this area are fighting in the closest possible cooperation under the unified command of the Navy.

In the Aleutians, Army forces in considerable numbers, under naval command, have occupied several of the Andreanof Islands. This operation, executed under adverse weather conditions and other handicaps, was signally successful. Within a few days Army troops had constructed an airfield from which fighter planes took off, and in ten or twelve days this field was being used by medium and heavy bombers as well as by fighters. This changed the entire picture in the Aleutians and provided us with an advance base from which Japanese at Attu, Agattu, and Kiska could be successfully attacked by our aircraft. One of the immediate results of this operation was the abandonment by the Japanese of the islands of Attu and Agattu. Now our planes, operating at relatively short range, are attacking the installations at Kiska whenever weather conditions permit.

Our planes based on the British Isles are coöperating with the Royal Air Force in frequent and devastating raids on German-occupied territory on the continent of Europe. In North Africa and over the Mediterranean, United States Army airmen are flying wing to wing with the Royal Air Force and are knocking out Axis shipping and German installations in Libya.

Along our own coast, in the Caribbean area, and along the coast of South America, Army airplanes are on constant submarine patrol, most of them under the direct command of naval sea frontier commanders. Secretary Knox, on his return from South America, stated that Adm. Jonas Ingram of the United States Navy and Brig. Gen. Robert L. Walsh of the Army Air Forces are working in the closest possible coöperation with the Brazilian Army and Navy for the defense of Brazil.

In China, General Stilwell and units of the U. S. Army Air Forces are aiding Gen. Chiang Kai-shek's army in the continuous harassment of the Japanese invaders. From their bases in India, American Army bombers are conducting frequent raids on the Japanese in Burma. At the head of the Persian Gulf, American supply troops are expediting the movement of our equipment to the Russian armies in the Caucasus. The Army has established a big supply base in Eritrea where tanks and motor vehicles are assembled and sent forward to the British armies in North Africa. Through the heart of Central Africa we have a series of landing fields for our planes that are flown to India, China, Russia, and Egypt.

A Tribute.—Maj. Gen. William Crozier, whose memory we honor on page 77 of this issue, was as keen in his foresight of the future needs of industrial preparedness as in his ability to solve the ordnance problems of his day. As Chief of Ordnance from 1901 to 1918 he laid the strong foundations which enabled the Ordnance Department to bear successfully the strains imposed upon it by World War I.

After that great conflict, General Crozier saw clearly the need for preparing against the possibility of another major war and of keeping alive the techniques and skills of armament making as a bulwark against future aggression. As a founder of the Army Ordnance Association, he wished this organization to help perpetuate these ideals of industrial preparedness for the defense of the country he loved so well and served so faithfully.

He has set forth the need for such preparedness in his own words in these pages, and we feel it is indeed fitting and timely to quote them again as an inspiration to the members of the Association. In the July-August 1930 issue of ARMY ORDNANCE (Vol. XI, No. 61, p. 21), General Crozier wrote:

> "We are all, therefore, still under the necessity of providing individually for our own security; and to do this, something like competition in armaments must go on. But we can give the competition a character a little different from that which it had in prewar time. Progress in design and in standards of manufacture must be governmentally encouraged and provided for, and plans of supply and distribution must be matured and kept up to date. These are functions of the permanent organization of the Ordnance Department.
>
> "But the war showed that the expenditure of munitions in the full swing of a conflict between great powers is so vast that to attempt to meet it by accumulation sufficient to tide over the interval from normal to required output, after the outbreak of war, would be prohibitively expensive, as well as unwise from the viewpoint of obsolescence. So our plan is to shorten this interval by making an understanding of the requirements of the Ordnance Department a part of the mental equipment of the leaders and executives of industry, and of the body of professional men whose work furnishes the scientific guidance upon which practical production depends.
>
> "The agency of this plan is the Army Ordnance Association; and it is thought not too much to hope that the interest of the membership may be such as to stimulate invention and the adaptation of plant equipment to the manufacture of munitions, so that the normal condition of industry may not be far removed from that which it is required to assume when meeting the demands of war."

Controlled Materials Plan.—The new, long-range plan for controlling the flow of critical materials into war production—the Controlled Materials Plan—has resulted from study of difficulties encountered in distributing essential materials through the priorities system, including the Production Requirements Plan, under which our war industries have been operating.

Under PRP, every firm, large or small, submitted to the War Production Board its individual requirements and received WPB individual authorization to obtain materials. These requirements were on a priority basis, but even with a high priority rating the manufacturer could not be sure he would get enough materials of the right kind he needed at the time he needed them.

This system resembled one method of irrigating fields now little used in the West, where water is allowed to flood dry lands at intervals without controlling its flow or measuring the requirements of the fields. The result is that parts of fields will be flooded, others will remain dry, and some will get no water at all.

The Controlled Materials Plan, like a modern irrigation system, will be based on knowledge of material requirements

all the way down the line, from prime contractors to subcontractors, and on a measured control of the flow of these materials from the "headgate" or national pool of critical materials down to the last channels and outlets of war industries.

Under the CMP, prime contractors assemble "bills of materials" specifying not only what materials are required, but when they must be received in order to meet approved production schedules on time. Included in the bills of materials are those materials needed by the prime contractors as well as subcontractors and their suppliers. Each prime contractor submits his total bill of materials to his particular "claimant agency." There are seven claimant agencies—Army, Navy, Maritime Commission, Aircraft Scheduling Unit, Lend-Lease, Board of Economic Warfare, and Office of Civilian Supply—which handle orders for their respective customers. Each claimant agency assembles its bills of materials and submits them to the WPB requirements committee and to the respective controlled-materials divisions.

The requirements thus presented by the claimant agencies must be brought into balance with the known available supply before they can be approved. All material requirements are divided into amounts needed for construction and facilities, including industrial machinery and equipment, and production and maintenance repair and operating supplies. When the sum of these various requirements has been adjusted to the supply, the WPB program vice-chairman —who is also chairman of the requirements committee—with the advice of his committee will allocate authorized quantities of "controlled materials" to each claimant agency.

The claimant agencies, in turn, distribute these broad allotments among their prime contractors by means of "allotment numbers," and prime contractors then pass on the allotment numbers to subcontractors, as they are needed to secure supplies. Allotment numbers constitute "certified checks" for specific amounts of material for delivery during specific periods. They are presented to mills with contractors' orders. Mills are advised by WPB as to the amount, size, and form of materials they should produce in order to meet the demand.

Carbon and alloy steel, copper, and aluminum are the first controlled materials to come under the plan, which will be put into effect partially in the second quarter of 1943 and completely by July 1st. Materials other than controlled materials will continue to be distributed through the priority system. Provision is made for companies to continue getting steel, copper, and aluminum under the existing priorities system and PRP until they qualify under the Controlled Materials Plan.

War Production.—The War Production Board chairman's report for September showed that 4-engined bombers rolled off the assembly lines very nearly on schedule. Acceptances of all heavy tactical types increased substantially. The result of a marked increase in the output of heavy aircraft and a decrease in light planes was a small over-all increase measured numerically; but measured by total value, which takes into account the difference between large and small planes, the volume of output in September was up ten per cent, compared with an increase of five per cent (revised) in August.

Propeller production continues to present a serious problem. Plane construction may increase in the months ahead more rapidly than propeller production, unless propeller output can be greatly stepped up. Thus far, however, enough propellers have been made to fly all planes.

Ordnance production continued to move slowly and, as between the various items of production, unevenly. Tank production in September was up three per cent and the production of tank guns was ahead of schedule. September was a good month for antiaircraft-gun output. Production of ammunition for the various types of guns was spotty, excellent records being made in some areas and disappointing results being reported in others. Over-all ordnance output rose seven per cent in the month.

Machine-tool production in September totaled $120,118,000 in dollar volume, compared with $117,343,000 in August, a gain of 2.4 per cent. Until recently, new machine-tool orders have been in excess of deliveries, causing a persistent increase in the backlog of unfilled orders. Production now is higher than new orders currently received, so that the backlog is being worked off. The trend in new orders has been downward since last spring.

In September, the Treasury and Government corporations paid out $5,500,000,000 for war purposes, an increase from August of $300,000,000. The average amount spent each day was $220,000,000, compared with $198,000,000 in August. By the end of September, war expenditures since July 1940 had reached $50,000,000,000, and the total program, including commitments of Government corporations, called for the disbursement of $224,000,000,000. This was increased in October to about $240,000,000,000.

The Year's Munitions.—During 1942, American industry turned out the following armament for our fighting forces: 49,000 airplanes; 32,000 tanks and self-propelled guns; 17,000 antiaircraft guns larger than 20 mm. In addition, 8,200,000 tons of merchant ships were produced.

These totals—except for ships—fall short of the goals set by President Roosevelt in January 1942—a month after the attack on Pearl Harbor. At that time, the President called for 60,000 airplanes, 45,000 tanks, 20,000 antiaircraft cannon, and 8,000,000 tons of shipping by the end of the year. Only 85 per cent of the production quotas asked for by the President were met.

These results were anticipated, however, not long before the above figures were released to the public. President Roosevelt told a press conference at that time that lessons learned in actual combat had led the Government to lower its volume schedules for tanks and planes in order to concentrate on heavier, more effective types of these war machines. He stated that while the number of tanks and airplanes produced would be smaller than scheduled a year ago, the amount of steel used in their construction would be essentially the same as planned originally. Mr. Roosevelt said the program for tanks a year ago called for a large scheduled production of M3 tanks, but that the experiences of warfare, particularly in the Libyan desert, had made it advisable to change over to the M4 tanks. The result was a lowering of the schedule originally set for this year at 45,000 tanks. The nation is not turning out as many units in tank production, he said, but the total production will have virtually the same weight, using the same steel tonnage as called for in the original, larger program. In dollar value, the results exceed the most optimistic predictions made a year ago.

Association Affairs

TEXAS POST INAUGURAL

A NEW name was added to the roster of local chapters of the Army Ordnance Association with the inauguration of the Texas Post on October 30th. The first meeting was called to order by Capt. George G. McDonald, officer in charge of the Houston Suboffice of the St. Louis Ordnance District, in the conference room of the Houston Chamber of Commerce, Houston, Tex. Captain McDonald then introduced Col. Merle H. Davis, chief of the St. Louis Ordnance District, and secretary-treasurer of the St. Louis Post of the Association, who presided until the election of permanent officers.

In giving a brief history of the Army Ordnance Association, Colonel Davis stated that the St. Louis Post has been in existence for seventeen years and included the State of Texas, now being taken over by the Texas Post. As early as last May, Colonel Davis explained, a communication was received by the St. Louis Post expressing the desire to establish a local post of the Association in Houston. This idea was encouraged and was forwarded to the national headquarters of the Association in Washington for further action. It was later decided that the Post should embrace the entire state of Texas and should be called the Texas Post. Invitations were sent to Texas ordnance contractors to attend the inaugural meeting, and 150 of these were present on October 30th.

The new constitution of the Post was then read and adopted followed by the selection of a nominating committee composed of Captain McDonald, William R. England, Michael Tierney, and Richard Bloss. The committee presented the following nominations for officers and directors who were unanimously elected: President: W. J. Gourley, American Manufacturing Company, Fort Worth; vice-president: B. T. McNeil, McEvoy Company, Houston; secretary-treasurer: 1st Lieut. R. D. Campbell, Dallas Suboffice, Dallas; directors: J. M. Kincaid, Jr., Kincaid-Osburn Company, San Antonio; Lieut. Col. Colin McRae, U. S. Army, Ret., Dallas; John E. Mitchell, Jr., J. E. Mitchell Company, Dallas; J. E. Rittersbacker, American Well & Prospecting Company, Corsicana; H. Sinclair, Long Reach Machine Works, Houston; W. C. Trout, Lufkin Foundry & Machine Company, Lufkin.

Following the election of new officers and directors, Colonel Davis turned the chair over to Mr. McNeil in the absence of Mr. Gourley, the new president. The by-laws of the Post were then examined and adopted. This was followed by a question-and-answer period during which Colonel Davis replied to a number of queries from the ordnance contractors present regarding various manufacturing problems.

Brig. Gen. R. H. Somers, U. S. Army, Ret., executive secretary of the Army Ordnance Association and managing editor of ARMY ORDNANCE, then presented the Post with its charter from the national society and addressed the meeting, congratulating the members on the establishment of a new Post and welcoming them into the national organization, which now has a membership of 14,000.

BRIG. GEN. JOHN K. CHRISTMAS

BRIG. Gen. John K. Christmas, assistant chief of the Detroit Tank-Automotive Center, spoke recently at the presentation ceremonies conferring the Army-Navy Production Award upon the Continental Roll and Steel Foundry Company, East Chicago, Ind. General Christmas' address is quoted in part as follows:

"A short time ago we were at peace. We felt secure and were certain that we Americans were too far away to be overconcerned with the troubled affairs of Europe. War was something we read about in the newspapers—along with the baseball scores. As a country of peace, we hated thoughts of war. We did not pour and mould red-hot steel to torture and twist human life, to build tanks and munitions, to snuff out lives and happiness. Instead, we poured steel for automobiles, steel for bridges, steel for office buildings, steel for factories, steel to build human comforts and luxuries, steel for public housing, slum clearance, and individual homes in which our people could live in traditional American family life. All of this, and more, we poured out with our steel. *Then*, with our steel, we poured molten rivers of happiness, convenience, better living. America was the greatest steel-producing country in the world—but it poured steel for peace!

"Today, all this has changed. *Now*, we too build for death and destruction. But the death and destruction for which we build were forced upon us. We build for destruction of evil, so that our ideals and hopes for a better world may arise out of the ashes and the chaos. . . As the avengers of an outraged peace, we gather all our fury into rivers of red-hot steel which now pour planes, tanks, ships, cannon, guns, and ammunition. It is the quantity of production of these which will determine the eventual outcome. Only if we can build more and better implements of war, can we hope to win!

"America, from the greatest peace-time producer, has become the greastest war producer in the world. That is our mission in this war. As the so-called "Arsenal of Democracy," we must stock that arsenal and keep it filled to overflowing. You who were workers are no longer merely workers. You have become production soldiers. It is your work which will ultimately determine whether or not we will triumph. It is your efforts which will decide how many of our boys will die, how many will live. Today, you no longer merely have a *job*—you are a soldier! You are the front line of offense and defense. Without *you*, our mighty armies would have no implements to fight with, no ships to carry them, no armor to keep the bullets from their bodies. In the degree that you win the war of steel production, we will win this war. This is a war of machines—*steel* machines. It is your job to make those machines possible."

General Christmas, until his present appointment, had been the chief of the Tank and Motor Transport Branch of the Ordnance Department. He took with him to Detroit all the Washington staff engaged in the engineering, production, and procurement of tanks, combat vehicles, and motor transport, except a small liaison group which will remain at the War Department in Washington.

General Christmas, long a member of the Army Ordnance Association, is well-known in Army circles and in American industry as a pioneer in the development of tanks. He has been at it ever since the last World War. He served in France, starting as a second lieutenant and returning as a captain. He fought in the St.-Mihiel offensive in 1918 and in the Meuse-Argonne offensive until the Armistice. In the intervening years between the first and second World Wars, in spite of many obstacles, lack of funds, and public disinterest, it was largely due to his efforts that tank development was kept going, so that today we are building the world's best tanks.

When the present emergency came along, General Christmas was placed in charge of the tremendous tank and combat vehicle program. As chief of the Tank and Combat Vehicle Branch of the Ordnance Department, it was not only necessary that he set up a staff adequate for the purpose, but at the same time he had to design new and better tanks, secure and build facilities where none existed, and keep up a mounting production schedule.

Germany had started building tanks in 1932. We did not actually start building tanks in quantity until 1941. Under General Christmas' direction, and with industry's whole-hearted coöperation, our tank program immediately gained momentum to a point where, in 1943, we are the producers of the greatest number of the greatest tanks in the world. American and United Nations

battle-front observers report that American tanks have proved superior to all other tanks in the field.

COL. A. W. HERRINGTON NEW NATIONAL DIRECTOR

COL. A. W. HERRINGTON, chairman of the board, Marmon-Herrington Company, has been appointed as a national director of the Army Ordnance Association, to fill the vacancy caused by the death of the late Maj. Gen. William Crozier of Washington, D. C.

Colonel Herrington recently assumed a directorship in the Aviation Corporation, replacing Tom M. Girdler who now will devote his time chiefly to the operation of Consolidated and Vultee aircraft companies, both of which are Aviation Corporation affiliates. Mr. Girdler will still be available to the parent corporation for consultation. He is also a national director of the Army Ordnance Association.

As president of the Society of Automotive Engineers and a governor of the American Society of Military Engineers, Colonel Herrington's abilities, as an executive and as an engineer, have been recognized. Only ten years ago, with the late Walter C. Marmon, he founded the Marmon-Herrington Company which is now one of the large producers of military units in the Midwest.

The Aviation Corporation and affiliates are builders of Consolidated and Vultee airplanes, operators of several plants building essential airplane parts, and operators of the New York Shipbuilding Corporation. Consolidated builds the famous B-24 bomber, and Vultee is a large producer of basic trainer planes for the Army and Navy.

Colonel Herrington was appointed by the President as technical adviser to Col. Louis Johnson on the American Economic Mission to India, for he possessed a thorough knowledge of automotive and aviation engineering and mechanics as well as familiarity with the geography and military possibilities of the present theaters of war. Colonel Herrington served, for several years, as consulting engineer to the Shah of Persia, and is responsible for the high efficiency of the mechanized units in the Iranian army.

COLONEL BAXTER HEADS NEW BRANCH OF WPB

COL. CHARLES R. BAXTER, Ord. Dept., executive secretary of the Army Ordnance Association and managing editor of ARMY ORDNANCE from 1926 until 1929, has been appointed chief of the new WPB materials redistribution branch. The new branch will take over the functions and personnel of the inventory and requisitioning branch, which has been responsible since December 1941 for the movement to war industries of idle and excess stocks of strategic materials. Colonel Baxter, a veteran of thirty years' service in the Army, was recalled to active duty in the Ordnance Department last January.

CHEMICAL WARFARE PERSONNEL CHANGES

BRIG. GEN. ALEXANDER WILSON, Chemical Warfare Service, former chief of Field Division, Office of the Chief of Chemical Warfare Service, has been assigned as commandant, Chemical Warfare School, Edgewood Arsenal, Md. Brig. Gen. Alden H. Waitt, formerly acting executive officer, Office of the Chief of Chemical Warfare Service, succeeds General Wilson as chief of the Field Division. General Waitt, a contributor to the pages of ARMY ORDNANCE, served in France in 1918 as Chief Gas Officer of the 94th Division and later, with the 29th Division. He served as secretary of the Chemical Warfare School from March 1921 to January 1924, and from July 1934 to August 1935. He is a graduate of the Gas Defense School (France), the Command and General Staff School, and the Air Corps Tactical School. He is the author of "Gas Warfare" a recently published manual for soldiers and civilians.

MR. BOODY OF FRANKFORD ARSENAL RETIRES

LEWIS W. BOODY, who has been an employee of the Frankford Arsenal since October 1, 1913, and chief clerk of the arsenal since May 1916, has been compelled to retire because of ill health. Mr. Boody first entered the service as a clerk in The Adjutant General's Office in November 1892—fifty years ago. His first assignment at Frankford was in the stock department, after which he was made purchase clerk and later was placed in charge of the cost and allotment section. In May 1916, he was appointed chief clerk, a position which he held up to the present time.

During World War I, one of Mr. Boody's duties was the instruction of a class of officers in Ordnance rules and regulations. While acting as instructor, Mr. Boody took an officer's examination, received a commission as major, and was directed to report to a certain post elsewhere. The commanding officer then at Frankford considered his services more important to the arsenal and, as a result, the commission was returned with request that it be cancelled. Mr. Boody is retiring with the thanks and best wishes of the Department he served so long and so faithfully.

NECROLOGY

MR. GEORGE A. GOSS, Chief Ordnance Officer of the First Army in the A. E. F. in France during World War I, naturalist, and executive, died in Waterbury, Conn., last October.

After an outstanding athletic career in high school and college, Mr. Goss, at the age of 23, took a trip around the world during which he collected rare specimens of birds, butterflies, and moths, and scaled Mt. Kina Balou in British North Borneo, a peak 10,000 feet high, to determine whether it was a volcano, as geographies then recorded it. On reaching the summit, the mountain was found to be composed of solid granite and not of volcanic origin.

Mr. Goss entered the employ of the Scovill Manufacturing Company in Waterbury as an apprentice, reaching the position of assistant superintendent of the manufacturing department in 1917, when he volunteered in World War I. After a period of training, he went overseas with a small group of volunteers, mostly from the Scovill Company, and was put in charge of the ammunition supply of the A.E.F. He was thus charged with the responsibility of purchasing vast quantities of munitions and guns from Great Britain and France as well as picking out the locations of ammunition dumps and storehouses and equipping and manning them. He also organized training schools to teach ordnance technique. With headquarters at Tours, Mr. Goss carried on this work for eleven months and was cited "for exceptionally meritorious and conspicuous services."

He then was transferred to the First Army of the U. S. forces as chief Ordnance officer, where he continued until the end of the war in the theater of operations.

Returning to this country he became superintendent of the manufacturing department at Scovill, which position he held until 1929 when failing health forced him to retire from active service. His son, Lieut. George A. Goss, Jr., is a member of the Association.

NOTICE also has been received of the deaths of the following members of the Association: C. E. Achuff, Newtonville, Mass.; E. W. Blanchard, Birmingham, Ala.; Ward Buchanan, Lewisburg, W. Va.; H. G. Heedy, Cleveland, Ohio; Charles S. Lindsay, Bridgeport, Conn.; David Meiklejohn, Mount Vernon, N. Y.; W. K. Norton, Washington, D. C.; Arthur K. Reading, Davenport, Iowa; E. Grant Tice, Bethlehem, Pa.; J. F. Van Lear, Wilmington, Del.; C. I. Wagner, East Orange, N. J. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

Ordnance in Review

THE MACHINE GUN—A PERIOD OF EVOLUTION, PART V

LIEUT. COL. CALVIN GODDARD

THE mitrailleuse was not the only machine gun available to the French when war was declared in 1870. The Gatling was already well known in France, as was the Claxton. Both were to see service under the tricolor, the first in General Chanzy's army, the second in the hands of General Faidherbe. Still another quick-firing gun, invented by a M. Mouceaux and embodying twenty-one barrels in three tiers, had been exhibited in Paris as early as 1867—apparently without evoking much interest among the military.

Nor were the Germans without a machine weapon of their own—and seemingly a good one. This was the Feld, no adequate description of which have I yet come upon. Hutchison refers to it as "similar to the mitrailleuse," but J. F. Owen calls it a "revolver cannon," and since his work appeared but three years after the termination of the Franco-Prussian conflict it is reasonable to assume that this description is correct—as far as it goes. Apparently the Feld saw use only in the Bavarian Army under General von der Tann. It seems to have slightly outranged the mitrailleuse, for Hutchison accords it a range of 1,500 yards. On the single occasion in which it appears to have figured prominently, the Feld, disposed in a battery of four pieces in the front line of a Bavarian infantry unit, engaged and defeated a French battery of field artillery some 1,000 yards distant. Thereafter, three French infantry counterattacks went to pieces under combined infantry and machine-gun fire, despite the fact that the ammunition for the latter showed many imperfections which in turn caused numerous mechanical failures in the weapons themselves.

Surprisingly, the Germans, despite such creditable performance on the part of the Feld, not to mention the decimation of their 38th (Prussian) Brigade at Mars-la-Tour, where two-thirds of its officers and half of its enlisted personnel were put out of action by the fire of the mitrailleuse, found no place for the machine gun in the tables of organization of their postwar armies. France, smarting in defeat, wanted no further dealings with that weapon upon which she had counted so heavily, and so erroneously, for swift success. But despite the low repute into which the machine gun fell in the eyes of the actual belligerents, it was far from destined to make a sudden exit from the military picture. Too many observers with both armies had seen what it could do when properly disposed and employed, and general staffs the world over were carefully studying their reports.

British military authorities in particular seem to have been deeply impressed by the performance of machine guns during the conflict of 1870-1871, and promptly adopted the Gatling, later supplementing this with various weapons of other makes which soon appeared. Numerous military writers contributed to the literature of the day their ideas on machine weapons and the part they would play in operations of the future. These were far from uniform and, in general, fell hopelessly short of visualizing the machine gun in the rôle it was destined eventually to assume. Even as late as 1879, the author of the Royal Artillery Institution Gold Medal Essay for that year* was advocating the incorporation of one Gatling as an additional piece in each battery of field artillery. His remarks appear worthy of the following extensive quotation as indicative of an important—perhaps the most important—element of contemporary British military opinion on the use of machine guns in battle:

"In reflecting on the power of the field artillery of the future we are naturally led to consider the question as to what place mitrailleurs will take. It appears that they have been rather too much discredited, owing to the ill success attending their employment in 1870. This result was chiefly due to two causes: *viz.*, the inferiority of the weapon itself and the faulty tactics which led the French to pit it at long ranges against the German field guns, the result being, in most cases, the total discomfiture of the mitrailleur. On the other hand, there is no doubt that it often occasioned most terrible slaughter among the Germans. Weapons of this nature have been much improved since 1870, and the Gatling of latest pattern seems, as far as we know at present, to be the best form . . .

"THE question now arises as to what proportion and what organization would best develop the power of the mitrailleur with the least corresponding disadvantages. We should advocate attaching one Gatling to each battery of artillery, though in doing so we know that there exists a strong opinion against this course. Placing Gatlings in separate batteries would undoubtedly

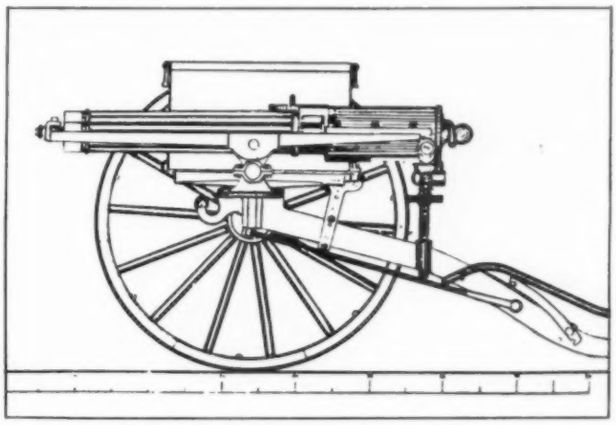


FIG. 9. THE GATLING MACHINE GUN

lead to their attempting to engage artillery at long ranges, when they would be pretty sure to be silenced. Moreover, the difficulty of seeing the effect of a mitrailleur renders an exact knowledge of the range essential. Combined in the same battery with artillery, the bursts of the latter's shells would indicate this to a great extent, but in Gatling batteries only this would not be the case. The special purposes of this weapon would be:

"1. To keep down the fire of any hostile skirmishers who might creep up within range and cause annoyance and loss to the battery. The importance of this service is manifest, more especially as this appears to be the sort of attack to which guns are most liable; direct attacks over open ground against a well-posted and well-served artillery firing shrapnel appearing to be pretty nearly desperate.

"2. To aid in repulsing such an attack if made. Its effect in this way would be very important. If, as we hope will be the case, bulletproof shields are adopted for field guns, the attack of hostile skirmishers by shooting down the gunners will be neutralized, and if it is required to take or drive off a battery, a direct attack will be necessary in great force. It would, however, be a most sanguinary business, and ought not to succeed. The Gatling would give great aid in repulsing it.

"3. To support the fire of the battery during the decisive moments of an attack, when the latter must often moye up within infantry range and when, in general, we may suppose the enemy's artillery more or less silenced. The chief object should then be the nearest infantry or that which apparently does the battery most harm. The mitrailleur should pour a continuous stream of balls on them and try to keep down their fire, thus reducing the losses of the battery, which, with shielded artillery, would be

*Lieut. F. M. Goold-Adams, R.A.: *Proceedings of the Royal Artillery Institution*, Vol. X, No. 7, 1879.

IT TAKES
MORE THAN FOOD
TO FEED A FIGHTIN' ARMY

★ To safeguard fighting foods for fighting men, Universal Cooler Refrigerating Units literally ride along with America's armed forces. Mobile units for the Marines and cold storage units for Army warehouses provide the dependable, automatic refrigeration that assures substantial, well-rounded meals for our soldiers.

But, it takes more than food to "feed" a Victory Army! And here, again, Universal Cooler's precision manufacture and engineering research are fully mobilized. Lubricating pumps for bombers, cooling equipment for machine guns, hydraulic mechanisms for aiming artillery, and refrigerating units for the Navy all are included in the "orders of the day" at Universal Cooler.

Meeting rigid military specifications and the production demands of total war is adding important "know how" to our 22 years of refrigeration pioneering . . . "know how" that will be invaluable in meeting the requirements of "all-out" commercial refrigeration after an Axis-smashing Victory.

★ THROW YOUR SCRAP INTO THE FIGHT ★

UNIVERSAL COOLER

MARION, OHIO

BRANTFORD, ONTARIO

WE SELL TO MANUFACTURERS ONLY

UNIVERSAL COOLER CORPORATION

Automatic Refrigeration since 1922

Ordnance in Review

chiefly in horses. It is most important that at such moments the mobility of the battery should not be seriously impaired; it would on such occasions be impossible to send the horses away and generally be difficult to place them under cover near the battery.

"4. The mitrailleur would be most useful in repelling a charge of cavalry.

"Hence the following rules for its employment: First, on the defensive, it should be kept as much as possible under cover during the preliminary artillery combat, unless the hostile batteries, from the nature of the ground or other causes, come within 1,200 or 1,300 yards, when it would probably be advisable to open fire on them with the Gatling. Should they be shielded, even then it would be of little use. Secondly, it should open fire on the enemy's infantry at about 1,500 yards, the ranges being supposed to be known and the bursts of the battery's shells giving the necessary corrections; the object of fire the same as the battery. It would then act as a seventh gun. Thirdly, on the offensive, it should be kept under cover as much as possible during the artillery combat but should, if possible, be placed in such a position as to command the ground in front; and those serving it should be particular to obtain the ranges of all places which would afford cover to the enemy, who, if the artillery has been pushed to the front, are sure to try to cause losses to the guns. If the guns are shielded, they will try and work out on the flanks. Fourthly, when the battery advances to close range to support the final attack, the mitrailleur should accompany it, as above mentioned. If the enemy's guns are shielded, they must be silenced or subdued by ours. Our infantry, however demoralized the enemy's may be, will not be able to advance if the ground be at all open, if the enemy's shielded guns can sweep them away at leisure, while our infantry can inflict little damage in return. The support of artillery will be more than ever necessary.

"The objects above stated appear to be more likely to be attained by dispersing the mitrailleurs among the batteries, where they can be made completely subservient to the needs of the battery and are wholly under the battery commander, than by placing them in separate batteries, which would rarely be able to carry out these tactics successfully from the difficulty which would often be experienced of finding the requisite cover close to a line of guns, and from the fact that their comparatively short range would prevent their effective fire sweeping the whole front of a mass of eight or ten batteries."

IN concluding this present series of articles on the machine gun it seems appropriate to add somewhat to the very brief biographical references thus far made concerning Richard Jordan Gatling. The following short account of his life is taken from Vol. X, No. 52, of the official house organ of the National Press Club of Washington, D. C. (Homer Dodge: "The Story of the Gatling Gun"):

"The Gatling family came from England about 1700. Jordan Gatling, the inventor's father, settled in North Carolina, acquiring lands on the Meherrin River near Murfreesboro in Hertford County. He owned some 1,200 acres of tilth and timber and was a large slave holder. He was a man of his hands, a skilled blacksmith and carpenter, and taught his slaves those mysteries.

"Richard Jordan Gatling was born at Manney's Neck, on his father's plantation, September 12, 1818. He had a common school education and, at the age of 15, became a clerk in the local courthouse for a time. Then he worked in a country store at Frazier's Cross Roads in his home county. Even as a boy he displayed the mechanical genius he had inherited from his father and an inventive bent. He invented a screw propeller only to find, upon sending in his papers to the Patent Office at Washington, that Ericsson had preceded him by a few months, in 1836.

"He invented a rice-planting machine and tinkered with various other devices. Then the call of the West seized him, and 1844 found him clerking in a drygoods store in St. Louis, but he con-

Ordnance in Review

tinued his mechanical tinkering in his spare time. It was there that he invented his wheat drill. He soon quit his clerking job and set out to sell his drill. He had scarcely any capital and hit on a sort of gamble to sell the implement. He would go to a wheat farmer and enter into a deal with him. A given acreage of wheat land would be selected. Half of it would be hand sown in the old broadcasting manner; the other half would be planted by the Gatling wheat drill. The excess production, if any, on the drilled portion, over that on the hand-sown portion, was taken by Gatling as first payment on a drill. He repeated this time and again through the Middle Western wheat states.

"While so engaged, he boarded a packet at Cincinnati, bound for Pittsburgh. He was scarcely aboard when he was seized with smallpox. The packet encountered bitter weather and was frozen in the river ice. There it remained for thirteen days. Gatling was without a physician and almost without food before the boat broke free. Arrived at Pittsburgh, the patient was taken to a pest house to die, and there he languished for three months.

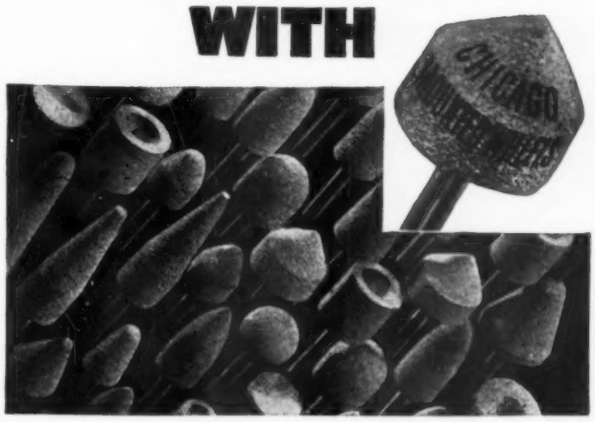
"Miraculously he recovered, and, appreciative of his narrow escape from death, he determined to study medicine. He attended the Medical School of Indiana and a further course at the Ohio Medical College. He practiced little; indeed it is difficult to find any but shadowy traces of his professional career beyond the fact that he was known by the title of doctor . . . In his capacity as a physician he had opportunity to examine the bodies of the dead from the battlefields and from the camps of the Civil War, as well as to assist in the handling of the wounded and sick. He was astonished to discover that only three out of eighteen had died of bullet wounds; the others had succumbed to fevers, pneumonia, and other maladies contracted in the campaigns.

"This seemed to Dr. Gatling to indicate a needless loss of life, and pursuance of the thought led him to the conclusion that if a weapon could be devised which would shoot more bullets, fewer men would be required to fight wars, and wars would inevitably be of briefer duration if not almost entirely discouraged . . . He built his first machine gun at Indianapolis in 1862. Even that first gun fired 200 shots a minute, a phenomenal performance for those days . . .

"His inventive genius never flagged. He made several improvements on the Gatling gun and also invented a gun-metal alloy which materially strengthened gun barrels. He stepped the firing of the Gatling gun up to 1,200 shots a minute and, finally, devised an electric firing control which delivered 3,000 shots a minute. He invented a power transmission system which provided for the sending of compressed air through underground pipes to any desired outlet where the force was applied to the operation of machinery. Curiously enough, the Patent Office denied him a patent on this idea, asserting that it was a discovery and not an invention within the meaning of the law. For six years he was president of the American Association of Inventors and Manufacturers and, finally, died in 1903 at the age of 85. He lies buried in the Crown Hill Cemetery at Indianapolis. The State of North Carolina has preserved his birthplace as a national shrine."

EDITOR'S NOTE.—This concludes the series of articles on "The Machine Gun—A Period of Evolution" begun in the May-June 1942 issue. These articles now are being reprinted in brochure form and copies will be available to readers of ARMY ORDNANCE without charge upon application to the Editorial Offices. A former series on "The Machine Gun—Its Early Applications," which began in the September-October 1941 issue and was concluded in the March-April 1942 issue, also was published in brochure form. In the next issue, Colonel Goddard will begin a new series on the machine gun which will bring the history of that weapon up to the turn of the century. An authentic background history of the machine gun is particularly timely since it is assuming an increasingly important part in today's conflict.

POLISH 'EM OFF WITH



Commandos of the grinding-wheel industry—the first small wheels mounted on steel shanks and leading the way today with smoother, more rapid grinding, polishing, and finishing of difficult jobs.

They're TOUGH and DO Their STUFF!

Chicago Mounted Wheels—the result of 45 years of KNOW HOW—come in a wide range of styles on different size shanks, for use with any portable or flexible-shaft grinder. Several special-formula abrasives give 150% to 300% longer service. More than 200 shapes, all mounted and rarin' to go.

Hi-Power Grinder

A real production tool—a 3-pounder with enough power to drive a 2½" diameter wheel. 17,000 r.p.m. In case with accessories, $38.50.

LATEST CATALOG—Packed full of comprehensive information and pictures. You'll be interested. Send for copy.

TEST WHEEL FREE. If you have a grinding problem, send for a Survey blank, which you'll find easy to fill out. Upon its return, our abrasive engineers will analyze it and send you without charge the trial wheel they recommend for your particular job.

CHICAGO WHEEL & MFG. CO.

Makers of Quality Products Since 1896
1101 W. Monroe St., Dept. AO
CHICAGO, ILL.

AO-10

☐ Send Hi-Power ☐ Catalog
☐ Free Wheel. Size.....

Name.....

Address.....

"General Grants"---

THEY'RE TOUGH, FAST AND HARD HITTERS!

Challenged by an aggressive enemy with years of war machine building experience, American engineers, in record time, designed, tested and built the famed "General Grant" tanks. Heavily gunned, tough and fast in the field, these steel monsters can out-fight, out-shoot and out-maneuver anything the Axis powers have yet rolled out. Such equipment is the pride of our Nation.

But it takes water to build tanks—water for the men who work in the plants—for those who produce the steel—for those who operate and service them—and for millions of other people in the Service of Supply. Before plants could be built, armies trained and munitions made, there had to be an abundance of water. Upon the old, reliable and capable shoulders of the Layne Organization fell much of the task of producing that water. Much more quickly than army and navy engineers anticipated, Layne swung into action and in record time, built deep well water systems by the hundreds, thus making possible unprecedented war and production programs.

Layne's reputation like that of the "General Grant" tanks, has been won on the field of action. Layne wells and pumps are doing an outstanding job—operating day and night, producing millions and millions of gallons of water for ordnance plants, munition factories, training fields, ship yards, air fields and many, many war material producers. For bulletins, address

LAYNE & BOWLER, INC.
Memphis, Tenn.

LAYNE PUMPS & WELL WATER SYSTEMS

Affiliated Companies

Layne-Arkansas Company ..... Stuttgart, Ark.
Layne-Atlantic Company ..... Norfolk, Va.
Layne-Bowler New England Corp. ..... Boston, Mass.
Layne-Central Company ..... Memphis, Tenn.
Layne-Northern Company ..... Mishawaka, Ind.
Layne-Louisiana Company ..... Lake Charles, La.
Louisiana Well Company ..... Monroe, La.
Layne-New York Company ..... New York City.
Layne-Northwest Company ..... Milwaukee, Wis.
Layne-Ohio Company ..... Columbus, Ohio.
Layne-Texas Company ..... Houston, Texas.
Layne-Western Company ..... Kansas City, Mo.
Layne-Western Company of Minnesota ..... Minneapolis, Minn.
International Water Supply, Ltd. ..... London, Ontario, Can.

WORLD'S LARGEST WATER DEVELOPERS

Preventive Maintenance

This is the first of a series of articles on standard preventive maintenance which will appear regularly in ARMY ORDNANCE. *Now that the Motor Transport Service of the Quartermaster Corps has been transferred to the Ordnance Department, Ordnance has the responsibility of research, design, development, procurement, storage, maintenance and distribution in connection with all Army motor vehicles—whether general or combat. This series is intended to acquaint Ordnance personnel with the need and application of preventive maintenance in today's fast-moving warfare.*—EDITOR.

PART I: ITS HISTORY AND SCOPE

WHILE the United States Army was experiencing its "growing pains" in the early part of 1941, it was discovered that destruction of Army vehicles was taking place in quantities that would have made our enemies feel more secure, had they known. As a solution to this self-destruction of our Army vehicles, the phrase "preventive maintenance" was introduced. But, like all abstract words or phrases, its interpretation was a matter of individual opinion. Preventive-maintenance procedures that one Army post thought were important were felt to be unimportant at another.

Obviously, a solution had to be found. And the answer, just as obviously, was standardization—a carefully planned program for use everywhere. In October 1941, the first long stride in that direction was taken by Col. H. J. Lawes, then acting chief of the Motor Transport Service of the Quartermaster Corps. He directed the Technical Service Division at the Holabird Quartermaster Depot (now the Maintenance Engineering Unit, Holabird Ordnance Motor Base) to develop a series of standard preventive-maintenance schedules. The directive faced the problem squarely, with such specific admonitions as those quoted below:

"Without making the style cumbersome, make sure that the text makes clear *what* to look for, *who* looks for it, *where* to look for it (largely by illustrations), *how* it is corrected when found (without too much detail), *why* these things should be done (the benefits), and *when* they are done. Include nothing which cannot be enforced or which we do not expect to enforce. Include nothing which takes more time and trouble than that which it may prevent. Do not require any inspection which takes more time than is normally available to those who must make the inspection. Make sure that the needed tools or equipment are on hand or can be secured."

The objective, then, was to iron out the differences between technical and military men—and among military men themselves—by evolving a set of standard preventive-maintenance procedures. The word "standard" was to be taken literally, with every limiting factor fully considered. The ultimate plan would clearly call for somewhat more than certain officers thought *could* be done, somewhat less than certain technicians thought *should* be done. It must be thorough enough to guard against faulty vehicle performance or premature vehicle failure, yet simple enough to meet the time demands of actual military routine under most conditions.

The new program would have to fulfill still another requirement: adaptability to both training and use. Instructional material must be supplied for vehicle drivers and mechanics, with provision for adequate supervision and check to insure performance of the schedules.

With these specifications in mind, joint committees of automotive technicians, military experts, writers and editors (mostly

from Holabird) prepared the original draft of the standard preventive-maintenance schedules—eight for trucks, three for motorcycles. The schedules were published in preliminary form and sent for exhaustive field tests to the 13th Battalion, 4th Training Regiment, Field Artillery Replacement Center, Fort Bragg; to the 1st Battalion, 22nd Quartermaster Regiment (Truck), Fort Dix; and to the 108th Quartermaster Regiment, 33rd Division, Camp Forrest. Additional tests were made simultaneously by units stationed at Holabird.

These field trials yielded many definite and constructive suggestions which were adopted. The revised schedules were retested in the field—and finally approved.

IN THEIR present form (which is subject to still further refinement), the standard preventive-maintenance schedules may be briefly summarized as follows:

PMS No. 1: "Special Services"—first and second echelons. (Including new-vehicle, cold-weather, desert, submergence, and other special preventive-maintenance services required by special conditions of operation.)

PMS No. 2: "After Operation"—first echelon. (The basic preventive-maintenance schedule of the daily group. Its purpose is to detect all faults developed during operation and to have the vehicle ready to roll on a moment's notice.)

PMS No. 3: "Before Operation"—first echelon. (A check to see that the vehicle's condition has remained unchanged since PMS No. 2; particularly valuable as a check against sabotage.)

PMS No. 4: "During Operation"—first echelon. (Simply a list of those mechanical factors which every good driver is constantly inspecting as he drives, such as the brakes, the clutch, and the engine.)

PMS No. 5: "At Halt"—first echelon. (A brief schedule covering those units of the vehicle which are most likely to develop troublesome defects while operating but which cannot be inspected until the vehicle is halted, especially the tires.)

PMS No. 6: "Weekly"—first echelon. (The weekly clean-up, *plus* an inspection and tightening procedure by the driver, covering all those items which might give trouble during the week to come.)

(These foregoing six preventive-maintenance schedules are designed for training purposes only; they should become second nature to the men who will perform them. Schedules No. 7 and No. 8, however, may be retained as records of each vehicle's condition.)

PMS No. 7: "Monthly"—second echelon. (A thorough inspection and lubrication by the company, battery, or troop mechanic, preferably with the driver assisting.)

PMS No. 8: "Semiannual"—second echelon. (The entire PMS No. 7 *plus* certain additional items which require semiannual rather than monthly attention. This is performed by a battalion or regimental shop.)

This series of schedules covers both wheeled and half-track motor vehicles. A similar but shorter series for motorcycles also has been adopted. A third program, for tanks, is now being formulated at Holabird with the assistance of tank specialists from Aberdeen Proving Ground and Fort Knox.

Standard preventive maintenance (based on the preventive-maintenance schedules) is a subject of growing importance at the Motor Transport special-service schools, in training courses for Motor Transport officers and "appreciation" courses for general officers, field officers, new division commanders and their staffs. In complete, definitive form, the standard program is being incorporated in a revised edition of the old technical manual on motor transport inspections (TM 10-545). The forthcoming manual will bear the new title, "Motor Vehicle Inspection and Preventive Maintenance Servicing." To provide illustration, a whole new series of driver-training films and film strips (now in production) will picture the actual performance of the preventive-maintenance schedules, step by step. (The next article of this series will discuss the driver's rôle in the field.)

PERHAPS HERE'S THE ANSWER TO *YOUR* FINISHING PROBLEMS

TO HELP YOU solve those tough finishing problems in connection with war production work, a complete line of industrial finishes is available from our modernly equipped, new paint plant.

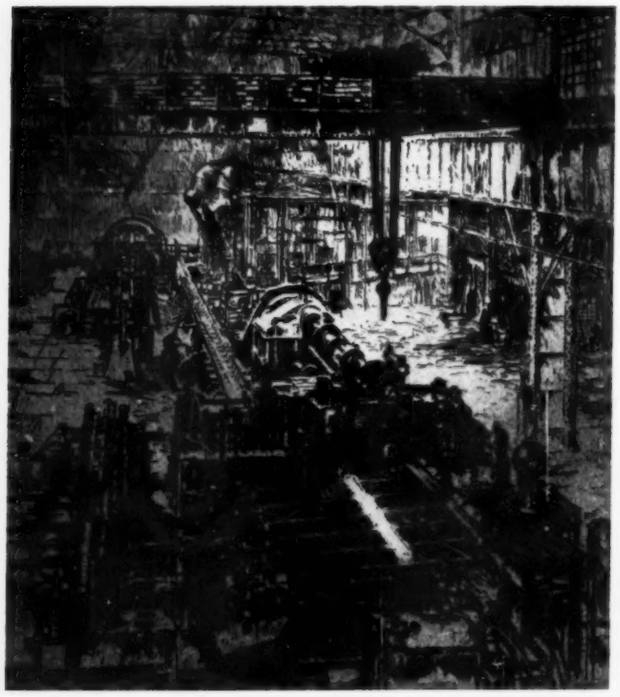
Our long experience in developing the exclusive varnishes and lacquers for Permite Ready-Mixed Aluminum Paints is now devoted to supplying U. S. Government specification finishes to war production manufacturers, for product finishing and for many interior and exterior uses.

The Permite Line of Industrial Finishes includes clear and colored ammunition lacquers, camouflage paints, zinc chromate primers, olive drab enamels, rust inhibitors, mixing varnishes and casein water paints. We can also supply Permite Aluminum Paints on WPB allocation.

Your inquiry will receive our prompt attention.

ALUMINUM INDUSTRIES, Inc., *Cincinnati, Ohio*
Distributors in Principal Cities

PERMITE *Industrial* **FINISHES**



Aetna's two great plants are working night and day producing the tools for Victory

ARMY E NAVY

The AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO, U.S.A.

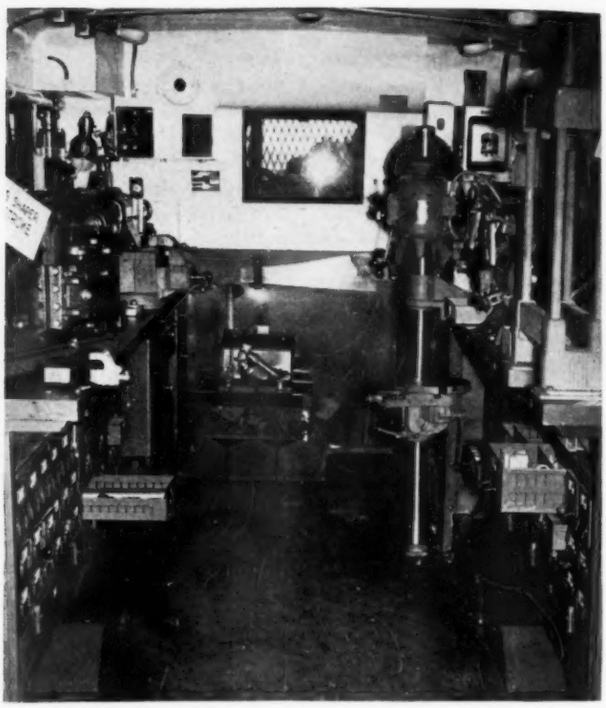
ASSOCIATED COMPANIES
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Professional Digest

A Provisional Medium-Maintenance Company

Lieut. Col. William F. Nee

In seeking a mobile Ordnance unit capable of handling a wide variety of field-maintenance services, a potential answer has been found in a provisional medium-maintenance company demonstrated recently at the Army War College, Washington, D. C. The company was evolved through numerous trials and tests, and combines maximum efficiency in many fields of maintenance. The traveling equipment of the outfit consists of forty-four vehicles including trucks, trailers, jeeps, new 1½-ton trucks, a command-reconnaissance car, a tank retriever, and two 37-mm. guns.



The Interior of a Machine-Shop Truck

The scope of maintenance to be provided by this company is an ambitious one ranging from jeeps to tanks along one line and from pistols to 155-mm. guns along another. To handle these many functions efficiently, the unit is divided into specialized sections, each one responsible for and fully equipped to maintain a particular type of matériel. As a secondary consideration, there are possibilities of some interchange of work if an emergency should swamp any one section and leave another one with available men and suitable machinery.

The sections into which the unit has been divided are headquarters, supply, automotive, artillery, small-arms, instrument, tank-recovery, and service. As is apparent from these designations, a multitude of skills must be provided in order to keep vital equipment in working order and rehabilitate damaged material. Some of the many skills in which this unit provides experienced service are electric-arc and oxyacetylene welding, carpentry, metalworking, painting, machining, blacksmithing, mechanics, and precision-instrument repair. In addition to these mechanical proficiencies, the all-necessary service of stocking the

thousands of spare parts used in repairing damaged guns, vehicles, and instruments, is performed by the unit's supply section.

Practically all the equipment is built into the trucks, and is designed to be used within them. Operations hit maximum efficiency, however, when the company sets up in a particular location, functioning in the trucks and also expanding to working positions around them. For example, each machine-shop truck contains a workbench and carpenter tools for inside use as well as welding equipment for both types of welding, including a regular Ford V-8 engine to generate the high current needed for electric-arc welding. Welding can be done either inside or outside. Completing the truck's supplies is equipment for blacksmithing—a portable forced-draft forge, an anvil, and the necessary blacksmith's tools. The forge and anvil are meant to be set up near the truck when parked.

Besides the actual automotive-repair work on vehicles, it is the duty of the unit to bring in those vehicles that cannot come to the company's position under their own power. For this purpose the large tank retriever is a part of the vehicular equipment, and three heavy-duty wreckers are included.

Recognizing that there are no guaranteed "behind-the-lines" positions in today's warfare, the provisional medium-maintenance company is more heavily armed than similar companies formerly were. Armament includes not only rifles, submachine guns, and other small arms which would provide protection against parachutists and small infiltrated groups, but also the two 37-mm. guns for use against tanks and armored vehicles. The personnel of this company, as provisionally formed, is from the Ordnance Base Shop School at Aberdeen Proving Ground, Md.

RAYON FOR TIRES

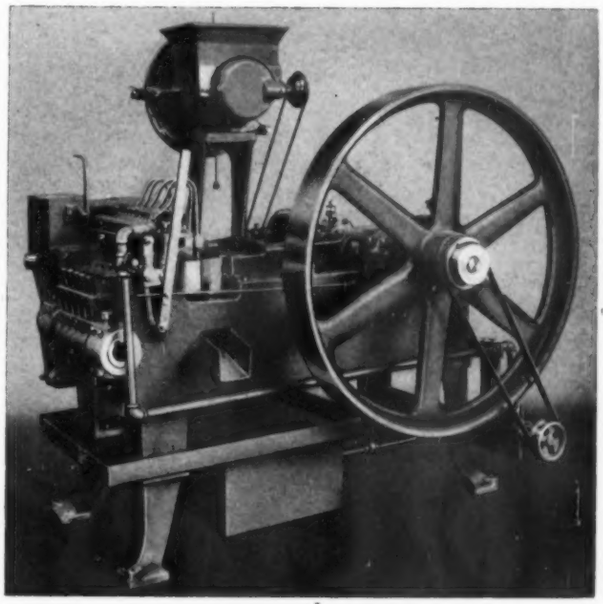
HARRY E. DALTON, deputy chief of the WPB Textile Section, reported that the WPB Requirements Committee had ordered in September the production of 50,000,000 pounds of rayon a year for military tires. The order has not been rescinded and the status is to go ahead with it. Mr. Dalton said that expansion of the rayon industry was not contemplated but that conversion would be undertaken. "We have 460,000,000 pounds a year of rayon capacity, of which 35,000,000 pounds goes into tires. We're going to change over 50,000,000 more pounds of capacity to high-tenacity rayon," he said. Ralph E. Loper, chief of the WPB Textile Conservation Section, said the conversion program would be concentrated in seven plants of five companies —E. I. du Pont de Nemours, American Enka, American Viscose, Industrial Rayon, and North American Rayon. Services of Supply commander Lieut. Gen. Brehon B. Somervell said that "high-tenacity rayon is necessary in airplane tires because of its lightness and strength and in combat tires because of its ability to withstand the high temperatures which are generated in these tires in flexing due to their extreme thickness." While tests with both rayon and low-gauge cotton cord are still being conducted, evidence to date indicates that high-tenacity rayon may be essential to the production of satisfactory tires in the larger sizes.

ORGANIZATION OF THE JAPANESE PLATOON

THE infantry platoon of the Japanese Army, as used in the Malayan campaign, consists of 42 men divided into 4 sections of 10 men each, a platoon commander who is a second lieutenant, and a noncommissioned communications officer. No. 1 section usually is commanded by a sergeant and Nos. 2, 3, and 4 by corporals. The platoon commander gives all orders for the sections. There are three platoons in each company.

According to *The Army Officer*, the first three sections of the platoon are armed with rifles, and the fourth, the grenade-discharger section, is armed with three grenade dischargers. Each rifle section is armed with one light machine gun, and consists of a machine gunner, two men who carry ammunition, and seven

SMALL ARMS
AMMUNITION
MACHINERY



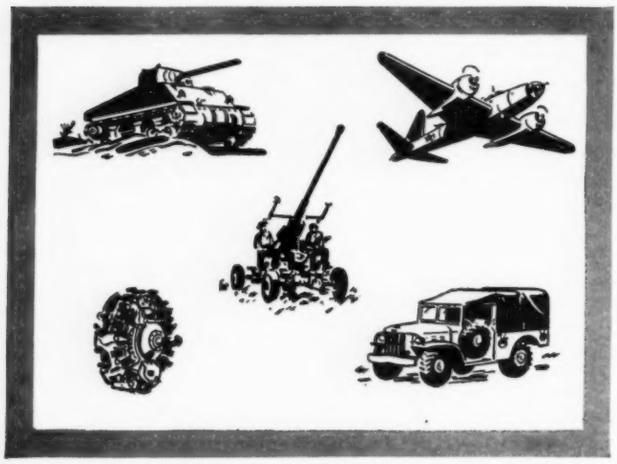
BULLET-POINTING MACHINE
(Improved Foreign Type)

Five operations available. Companion machine takes cup and preforms all draws, with possible clip trim.

One of our large family of Small Arms Ammunition Machinery. This line is the outgrowth of long experience in the development of machinery for the mass production of bullets, cartridge cases, etc., and the handling of explosives.

While the equipment is used extensively in U. S. Government Arsenals, the line includes also various machinery adapted to the manufacturing practices of England, Canada and other foreign countries.

WATERBURY FARREL
FOUNDRY AND MACHINE COMPANY
Waterbury Connecticut, U. S. A.
SALES OFFICES:
CHICAGO CLEVELAND NEWARK, N. J.



GOOD NEWS FOR OUR FIGHTING MEN!

When the Army-Navy "E" flag is hoisted over a plant —it signals good news to our fighting men!

When it's hoisted simultaneously over *seven plants* with more than 45,000 employees in them, it is even better news!

That is what happened not long ago at Chrysler Corporation—in addition to the "E" flags which were awarded earlier to the Detroit (Chrysler) Tank Arsenal and to Chrysler Airtemp.

These coveted banners—tributes to war performance —are stirring symbols of action on the home front.

They mean that the mighty forces of American industry, trained through peacetime years of enterprising service to our people, are now in full play—production executives, master mechanics, engineers, skilled workmen and operating leadership—pounding out fighting tools for fighting men.

They mean that tanks, guns, planes, munitions, military vehicles and other weapons of war are rolling off the production lines according to the high-precision standards born of free American ingenuity and initiative.

They, also, mean that those organizations so recognized have dedicated themselves to backing up *to the fullest extent* the men on our fighting fronts.

AMERICAN BUSINESS ENTERPRISE WORKS FOR VICTORY

ARMY E NAVY

PLYMOUTH • DODGE • DESOTO • CHRYSLER
DIVISIONS OF CHRYSLER CORPORATION

WAR PRODUCTS OF CHRYSLER CORPORATION — Tanks Tank Engines • Anti-Aircraft Cannons • Bomber Fuselage Sections • Bomber Wings • Aircraft Engines • Wide Variety Ammunition • Anti-Tank Vehicles • Command Reconnaissance Cars • Weapon Carriers • Troop Motor Transports • Ambulances • Marine Tractors • Navy Pontoons • Air Raid Sirens and Fire Fighting Equipment • Powdered Metal Parts • Bomb Shackles • Field Kitchens • Cantonment Furnaces • Tent Heaters Refrigeration Compressors • Marine and Industrial Engines

Professional Digest

riflemen. There are no organized subsections, and the light machine gun group is not intended to be split for action. No submachine gun is included in the section armament. Hand grenades are carried by all. In the grenade-discharger section, one man carries and fires each discharger, and two men, armed with rifles, carry ammunition for each weapon. This section is not intended to be split but operates as a unit reserve of fire power.

The Japanese platoons in Malaya apparently did not use antitank rifles. Instead, they used a variety of antitank bombs and time bombs which were effective in the jungle where close approach was possible, but in open country they would be useless.

According to information derived from prisoners, the following are the most frequently used battle tactics:

Sections 1 and 2 make frontal assaults on the enemy while Section 3 attacks the enemy's right or left flank. The section rarely ever divides into subsections to attack both enemy flanks at a given time because of the danger of hitting their own men by cross fire from two flanks, and because of the danger of weakening section strength, particularly since there is only one light machine gun to a section. Section 3 may be divided into one big subsection and one small subsection, but the smaller subsection is used more as a decoy than for attack. The grenade-discharger section, No. 4, usually operates in a reserve-fire-power position. It is usually located in the center of the formation between and slightly to the rear of Sections 1 and 2. The light machine guns of the first three sections are used only in front and hardly ever as reserve fire power.

Motor transport is used mainly for the movement of troops and supplies, including ammunition. One prisoner of war stated that he traveled on motor transport most of the way from the Thai border deep into Malaya, adding that a short distance of the way was traversed on a bicycle and that only very little walking was done. There is no platoon truck. The individual soldier carries all of his equipment, which includes digging tools. The normal platoon organization does not include motorcycles, but bicycles are an important means of transportation. Bicycle troops are organized separately from the infantry.

The independent mobility of the Japanese is assisted greatly by simplification of mess arrangements. Each man carries in his pack one day's emergency rations and five days' supply of rice. Since each is responsible for his own cooking, there is no waiting for hot meals to be brought up in rolling kitchens. Generally, the men of a section cook their food on a coöperative basis; no special cooking stove or other cooking apparatus is carried. Often a fire is made only once a day—in the morning—when enough food is cooked to last for the day. To a considerable extent, the soldiers live off the country. The quality of rations deteriorates as operations develop in intensity, and often rice and salt are the only foods.

Smoke Screens Helped Defeat the Maginot Line

How smoke was used by the Germans in their penetration of the Maginot Line is related by Col. Alden H. Waitt, C.W.S., in his book "Gas Warfare" (Duell, Sloan & Pearce). The action took place against the strongest point of the Maginot Line between St. Avold and Saaralben. The permanent steel fortifications and field emplacements of the French were on high ground behind wide basins of dammed-up water. Wide rows of barbed wire in the swampland adjacent to these basins, and along the edges of the basins themselves gave the impression that an approach to the French positions or a crossing of the water was impossible. The French, who felt themselves doubly secure behind their concrete and steel, could direct the fire of their machine guns and rapid-fire cannon against every knoll and every depression of the ground before them.

The German division artillery commander ordered a smoke battalion to screen the line of fortified hills and the slopes on

Professional Digest

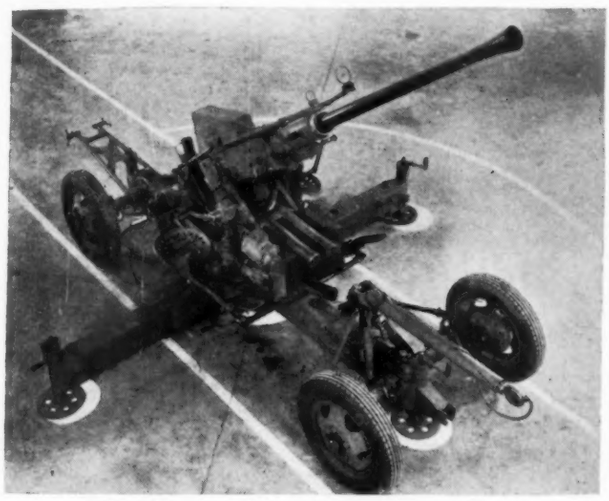
the far side of the bottoms. A nearby village, also fortified by the French, was likewise to be enveloped in smoke to prevent observation. The plan was to blind these places so the German infantry could go around both sides of them and destroy them from the rear. The smoke was to make it impossible for the French to direct accurate fire at the flanks of the infantry.

The smoke weapons were taken apart, carried forward, reassembled, and put into their positions. The tubes scarcely projected over the top of the emplacements. To the rear was a chain of ammunition carriers. The shells were piled near the guns and camouflaged with grass. On a knoll a hundred paces farther forward, holes were dug for observation posts.

The smoke weapons with their heavy 5-inch tubes were all pointed in identical direction with identical elevation. At 8:20 A.M., the smoke units opened fire and a favorable wind helped out. Every fifteen seconds each gun discharged one smoke shell. After a few minutes, a dense smoke cloud as high as a house covered the French position and the foreground over a width of nearly two miles and for a depth of a quarter of a mile. During the next two hours additional smoke projectiles were fired into the smoke zone to deny the French all observation. In the meantime, the Nazi assault units delivered their attack.

WELDING THE 40-MM. ANTIAIRCRAFT GUN CARRIAGE

THE carriage of the 40-mm. Bofors antiaircraft gun has been redesigned from riveted to welded construction, cutting costs and increasing strength fifty per cent. This development has been described in a paper which won the author, Dr. J. L. Miller,



THE BOFORS 40-MM. ANTIAIRCRAFT GUN

chief metallurgist, Gun Mount Division of Firestone Tire & Rubber Company, Akron, Ohio, the second grand award of $11,200 in the 2½-year $200,000 welding-study program sponsored by the James F. Lincoln Arc Welding Foundation of Cleveland, Ohio.

The chassis and outrigger supports of the gun were redesigned with high-strength low-alloy steels, and although only thirty per cent more weight was added, strength was increased fifty per cent. Cost per chassis was $76.80 less than with riveted construction. The top carriage was redesigned for welding with a net saving of seventeen pounds as compared with riveted construction of equal strength. Appearance was improved and cost was reduced $10.37, excluding overhead or profit. The design, involving tubes and cast-steel ends joined by welding, saved about $68 per axle. A number of other smaller parts were also redesigned. The total saving estimated was $171.43 per carriage.

Tents Stand Up in Combat, Army Says

[The Butterworth Organization is producing Gun Mounts for the U. S. Army.]

On the desert . . . in the tropics . . .

In sand storms . . . in driving rain . . .

Tents made for the Army by the Textile Industry are "standing up well in actual combat."

So say the men of the Quartermaster Corps who are serving at the front.

Government demand for cotton duck is practically unlimited. Recent bid invitations call for materials for tents, leggings, hammocks, stretchers, gun covers, life rafts, gas-mask covers.

In the bleaching, dyeing and finishing of the finest cotton duck, Butterworth Machines have an important rôle to play.

On the application of water repellents alone, Butterworth Jiggs, Padders, and Compartment Machines have a full-time job to do.

Because of the tremendous strain placed on mechanical equipment by today's unprecedented demand, mill superintendents are on the alert to detect the first sign of let-down in quality or quantity of production.

The Butterworth Organization is at your service to help you to improve, repair or replace obsolete equipment to the best of our ability.

Let our experience serve you now.

H. W. BUTTERWORTH & SONS COMPANY

Philadelphia, Penna. Serving the Textile Industry Since 1820. Offices: Providence, R. I., and Charlotte, N. C. In Canada: W. J. Westaway Co., Hamilton, Ont.

Butterworth

2 WAYS
TO PRODUCE SHELLS
(AND OTHER WAR PRODUCTS)
—FASTER!

ALVEY-FERGUSON Scientifically Planned Conveyor Systems are now helping to move shells, bombs and cartridges through processing and ordnance plants at speeds never dreamed possible just a few months ago. "Endless-Stream" production methods, developed by Alvey-Ferguson engineers, have done much to aid the science of Logistics—so vital to Victory!

ALVEY-FERGUSON specialized Metal Products Washing Machines now speed-wash and speed-dry shells, gun barrels, cartridges; soap and speed-dry cartridge cases and other weapons for war by means of super-spray and super-dry systems.

FOR A DISCUSSION of your materials-handling, products-handling or metal products washing problem, write, wire or telephone today. Or write for folders describing the use of Alvey-Ferguson Conveyors for "Endless-Stream" Production and A-F Metal Products Machines for cleaning, drying, soaping or oil slushing. The Alvey-Ferguson Co., 96 Disney St., Cincinnati, Ohio.

CONVEYING A-F MACHINERY
ALVEY-FERGUSON
PRODUCTS WASHING MACHINES
AND Conveyors

Professional Digest

Caterpillar Forms Engineer Shop Company

CATERPILLAR Tractor Company, Peoria, Ill., has sponsored a Corps of Engineers heavy shop company, composed chiefly of skilled men from its Peoria plant. The shop company is now in training for active service under command of Capt. Jean Walker, formerly export representative for Caterpillar.

This company was the first equipment manufacturer to respond to the call of the Engineers for an organization comprised of skilled man power to keep the machinery of the Engineers rolling. The company consists of 199 officers and men, all volunteers, most of whom will become noncommissioned officers or technicians.

The group left Peoria in a body with appropriate farewell ceremonies, witnessed in the heart of the city by thousands of persons who gathered to pay tribute. Included among the speakers were Col. M. M. Dawson, chief of the requirements, storage, and issue branch, Supply Division, Corps of Engineers, and L. B. Neumiller, president of the Caterpillar Company.

Army Experts Test Equipment on Mt. McKinley

MT. McKINLEY, the highest mountain in North America, was conquered for the third time last summer by a group of Army experts, it was announced recently. It was the first party to scale McKinley in ten years. The party lived high up on the mountain at altitudes varying from 15,000 to 18,000 feet for three weeks testing equipment for the Quartermaster Corps, Air Forces, and Ground Forces. They also tested foods and determined the strains that humans can endure, and the effects of living at such high altitudes. The expedition was led by Lieut. Col. Frank G. Marchman of the Quartermaster Corps. While Colonel Marchman and eight others remained at the base camp, seven men scaled the summit just over 20,000 feet. Among those who got to the top were Capt. Bob Bates and Maj. Albert Jackman, representing the U. S. Army Ground Forces. Major Jackman at that time was test officer in General McNair's new mountain regiment, the 87th. Over a ton of equipment to be tested was dropped from bombers, from PT-3 transports, and smaller planes by parachute. Many interesting discoveries that should play a real part in winning this war were made. They found out what concentrated foods are best for use in cold climates, and, perhaps more important, what articles of clothing should not be worn. They came back convinced that the "layer theory" is the sound one; namely, an outer thin layer of clothing and under that layers of woolen garments. They also found that the new Army equipment now in use is better than anything that explorers have ever used in the past.

German Focke-Wulf 190 Motor Copied from Pratt & Whitney Twin Wasp

GERMANY'S latest threat to allied air domination, in the form of the new BMW 801A power-plant being used in her Focke-Wulf 190, Focke-Wulf Kurier, Dornier, and Blohm and Voss planes, has proved on inspection to be a development from the Pratt & Whitney 14-cylinder twin Wasp motor being built extensively in this country, according to *Iron Age*. Experts who have analyzed the motor in England describe it as being basically an orthodox, twin-row radial with new improvements to the cooling system and the cowling designed to stabilize oil cooling and reduce air drag.

The design change is built around a 12-blade fan which rotates at 3.14 times the propeller speed. It gives adequate cooling at high speed and with low forward speeds. The oil cooler is mounted behind the fan in the cowling so as to receive a reverse-flow, low-velocity cooling. This automatically eliminates the need for a separate oil radiator and gives double utility to the

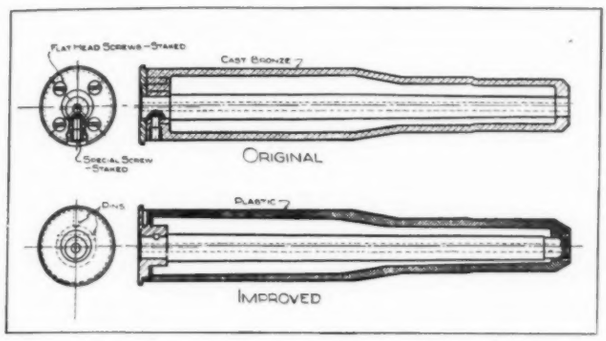
Professional Digest

single fan. The air intake for the motor and cabin heater is also through the cowl. Since all air intake is through the cowl, no controllable gills are needed such as normally disturb the air flow behind the nacelle. As a result of these changes, operating efficiency has been raised and air drag eliminated to the point where the motor develops 1,580 horsepower for the take-off and 1,460 horsepower at 16,300 feet.

Tremendous Trifles

THE Cincinnati Ordnance District office has contributed to the war production program savings of time and material due to the redesign of three components. These components at first sight seem to be insignificant and to offer a poor field for savings, but they have turned out to be "trifles" on which savings are "tremendous."

The first item is a lead cup holder used in a burster assembly. Originally it was machined from steel bar stock. By substituting molded plastic for the steel, about 40,000 pounds of steel, costing approximately $8,000, have been saved; a screw machine, two drill presses, and cadmium-plating equipment have been released for other uses; and the inherent uniformity of molded plastics has reduced substantially the amount of inspection required.



THE PLASTIC CARTRIDGE CASE IN SECTION

In another item, molded plastic has been substituted for cast bronze in a subcaliber-rifle cartridge case (see illustration). The use of 5,800 pounds of plastic in the place of 30,000 pounds of bronze, a critical material, effected a monetary saving of over $4,000. The savings on machinery costs have not yet been determined but will be greater than on the material.

The third item is one in which a special rolled steel section has been substituted for standard bar stock in fabricating certain rubbing plates used on tanks. Savings here amount to 1,500,000 pounds of steel (worth about $32,600), about 34,000 machine hours of work, and the release of 10 critical machine tools for other purposes.

Disposal of Unexploded Bombs

IN February 1942, the Office of Civilian Defense discontinued the civilian bomb-disposal squad and its place was taken by the Ordnance Bomb Disposal Company. Only Ordnance personnel are now charged with the removal and disposal of unexploded bombs, although Ordnance officers are training selected civilians within the various O.C.D. regional areas for assignment to control centers as "bomb reconnaissance agents." These agents merely are to confirm the presence of an unexploded bomb. Under the present set-up, the War Department is responsible for bomb-disposal activities, and not the local police department, as was stated in "The Fourth Defense Service," published in the November-December 1942 issue of ARMY ORDNANCE (Vol. XXIII, No. 135, p. 470).

Extraordinary TORQUE

is developed within the

MAGDRAULIC ELECTRIC BRAKE *itself!*

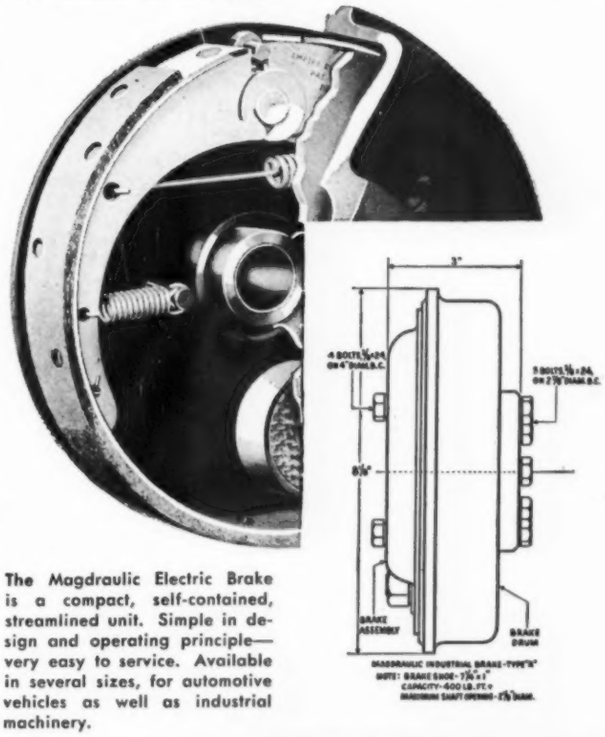
SUPER-POWER BRAKING SUPPLANTS AUXILIARY BOOSTER

Make more! Make it faster! Machine production, driving at breakneck speed is still nowhere near a levelling-off point. Efficiency is being measured in terms of how much, how soon!

Slipping brakes are saboteurs of production. If they've been your problem, ponder these facts in the case of Mr. L, operating injection plastic-molding machines on war orders:

"With a solenoid-type brake, pressure of 50,000 lbs. per sq. in. caused slipping . . . spoilage of material ran to 60% . . . a changeover to Magdraulic Electric Brakes eliminated slipping, cut man-hour waste 90%, increased allover production 48%."

Before freezing new designs on your industrial machinery consult with our engineers, particularly where high pressures, overloads, and brake boosters are involved. Write today!

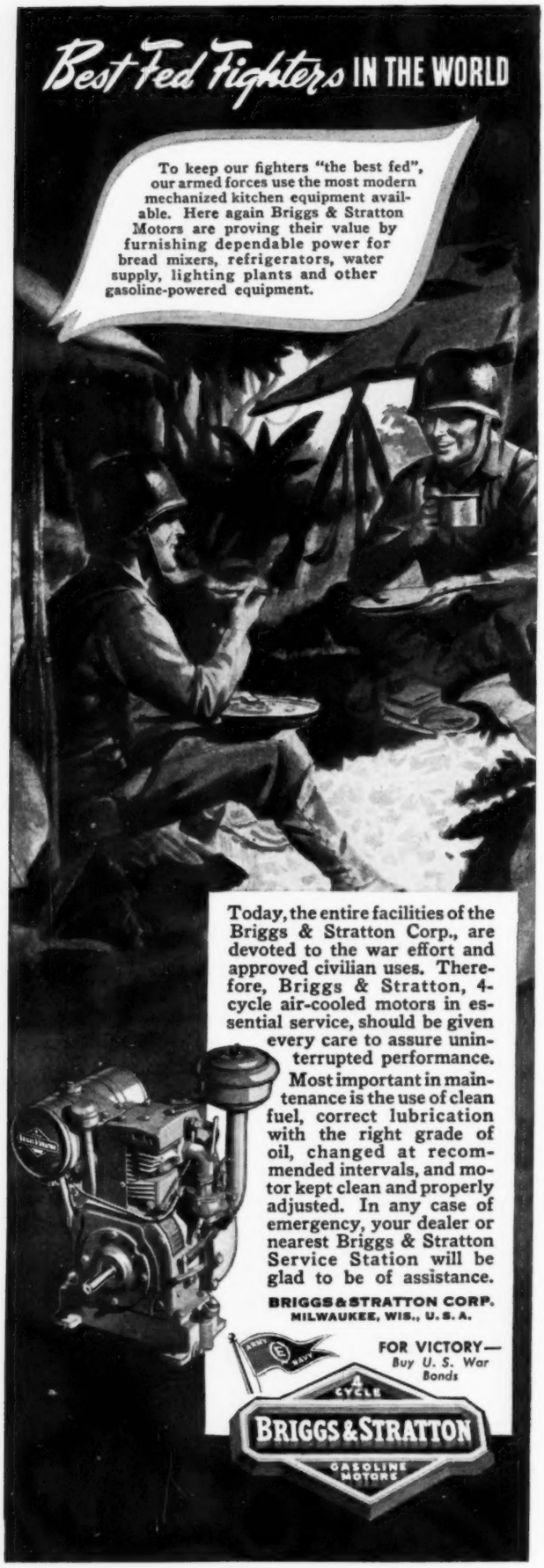


The Magdraulic Electric Brake is a compact, self-contained, streamlined unit. Simple in design and operating principle—very easy to service. Available in several sizes, for automotive vehicles as well as industrial machinery.

Write at once for complete data units on the Magdraulic Electric Brake, to

EMPIRE ELECTRIC BRAKE CO.
Newark, N. J.

MAGDRAULIC ELECTRIC BRAKES
FOR AUTOMOTIVE VEHICLES AND INDUSTRIAL MACHINERY


Best Fed Fighters IN THE WORLD
To keep our fighters "the best fed", our armed forces use the most modern mechanized kitchen equipment available. Here again Briggs & Stratton Motors are proving their value by furnishing dependable power for bread mixers, refrigerators, water supply, lighting plants and other gasoline-powered equipment.
Today, the entire facilities of the Briggs & Stratton Corp., are devoted to the war effort and approved civilian uses. Therefore, Briggs & Stratton, 4-cycle air-cooled motors in essential service, should be given every care to assure uninterrupted performance.
Most important in maintenance is the use of clean fuel, correct lubrication with the right grade of oil, changed at recommended intervals, and motor kept clean and properly adjusted. In any case of emergency, your dealer or nearest Briggs & Stratton Service Station will be glad to be of assistance.
BRIGGS & STRATTON CORP.
MILWAUKEE, WIS., U. S. A.
FOR VICTORY—
Buy U. S. War Bonds
4 CYCLE
BRIGGS & STRATTON
GASOLINE MOTORS

Aërial Gunnery

WITH bombers coming off the assembly lines in increasing numbers and the scope of Army Air Forces operations expanding in all parts of the world, the demand for aërial gunners continues to be urgent. United States gunners already have scored victories against heavy numerical odds in this war. Others fresh from concentrated courses on flexible-gunnery ranges are on their way to join those veterans on the far-flung line of American offense.

Air Forces gunnery schools are in operation at Harlingen, Tex.; Las Vegas, Nev.; Panama City and Fort Myers, Fla. Classes of gunners, qualified by five weeks of intense study and practice as aërial marksmen, are graduated weekly at each of these schools. The gunner graduates have fired submachine guns at miniature metal airplanes, caliber .22 machine guns at moving targets, caliber .30 guns with a tempo of 1,200 rounds a minute, and twin .50's from turrets. They have hit small sleeve targets towed by airplanes at 180 miles an hour. While blindfolded, they have taken machine guns apart and put them together again. They know every part by name and touch. They can identify at a glance all military planes and surface war craft.

The schedule and equipment at the Harlingen Army Gunnery School, in the Magic Valley of the Rio Grande, is typical of those at other Air Forces flexible-gunnery training stations. Gunner candidates usually arrive on Saturdays and Sundays. The average class at Harlingen includes men from every state whose previous experience in other branches of the Army varies widely. Five classes are progressing through the school at all times—as one group graduates, another begins the course.

WORK for the first-week class begins at dawn on Monday. The men are up at 5:15 A.M., and roll call is fifteen minutes later. From then on, things move fast. Calisthenics, breakfast, and inspection of quarters are over and the men are in classrooms by 7:30 o'clock. Classroom work, varying from ballistics to airplane identification, continues until late afternoon with an hour off for mess. From the classes the new students go to the drill field, where they are joined by the more advanced gunner students for an hour of calisthenics. Stress is placed on exercises to strengthen the finger, hand, and wrist muscles. Aërial gunners must have strength and staying power in their hands. Games follow, but there isn't much time for even informal recreation at Harlingen—the gunner candidates get their fun from studying and shooting. After dinner, most of the students study two or three hours. They have a lot to learn in a little time.

By the second day the students are ready to begin dovetailing studies with shooting on the skeet range. Nationally known trap and skeet marksmen show the students how to handle 12-gauge shotguns, emphasizing the indelibly important principle of leading the target. Gunner candidates fire 250 rounds on the skeet range in the first 10 days. Most of them show marked improvement in the last 100 shots.

Another phase of the early part of the course which has wide appeal for the students is the submachine-gun gallery, where they shoot at the silhouettes of small metal airplanes moving at a speed of 400 feet a minute on 4 levels. The class, divided into groups of seven or eight men with a sergeant or corporal in charge of each unit, moves on to the caliber .22 machine-gun targets. Here they get the actual feel of a machine gun for the first time and learn more about the various types of sights.

The gunner candidates put some of their most important classroom work to practical test on the malfunction range. There are fifteen caliber .30 machine guns and something is wrong with

each of them. The student must diagnose the stoppage on each gun and fire it. The ailment might be a missing firing pin, a jammed ejector, or any other of a score of mechanical headaches for the student. When he gets over this hurdle, the gunner student feels much surer of himself and knows a great deal about machine guns. Other important elements of the first two weeks of the course are range estimation, study of effect of wind on flight of bullets when fired at various angles from airplanes, and practice in sending and receiving signals.

AFTER passing written examinations on the basic studies, the students get into trucks for a ride to the ground range, a wind-swept coastal flat that knew only scrub mesquite and rattlesnakes until a few months ago, for two weeks of intensive shooting. One of the first steps on the range program is skeet firing with 12-gauge shotguns mounted on machine-gun swivels. These guns are fired with specially rigged machine-gun triggers on the stocks, and the sights are the same as those on the caliber .30 guns. The student gets practice in shooting and aiming mounted guns quickly. Firing with rifles at small targets pegged into the ground follows, and then the student goes to the caliber .30 guns on flexible ground mounts.

These guns are fired at stationary targets, 6 by 6 feet, at 200 yards and then at 500 yards. The student soon begins to get numerous hits at 200 yards, but at the greater distance his score is very low. The instructors emphasize that he must learn to fire only when his target is in effective range, particularly while in the air. They say: "If you can't hit him, he can't hit you. His range isn't any better than yours, and your ammunition while in battle is precious."

For the fourth week, the class moves on to the caliber .50 twins in turrets on the railroad target range. Triangular targets, mounted on electrically driven cars, move at from 20 to 70 miles an hour on an oval track varying in distance from 200 yards to 500 yards from the battery of .50's.

Four turrets fire simultaneously at the same target. Each gunner uses ammunition of a distinctive color. One shoots bullets tipped with red paint; another, blue; the third, green, and the fourth uses plain bullets, and the shots leave telltale marks on the target when they strike. Every fifth bullet is a tracer.

The gunners fire in bursts of from two to six shots. Then the instructor corrects their fire and gives them more pointers on the handling of the turret guns. Each man shoots many rounds from the caliber .50 guns at the moving target. Night firing, with thousands of rockets illuminating the prairie, completes the work on the range. The gunner candidates are then ready for aërial shooting—the acid test of the course.

The gunner, who now goes on flying pay, installs a caliber .30 gun in the rear cockpit of a trainer plane, and the pilot takes off for the Gulf of Mexico. Another plane towing a sleeve target maneuvers into position. The first firing is at 100 yards, with various relative speeds from the sides, above, below, and crossing. The gunner must get 15 per cent hits. He then takes the final test, firing at a sleeve target at 200 yards. This is his most important maneuver—those making less than 10 per cent hits on the target fail to graduate.

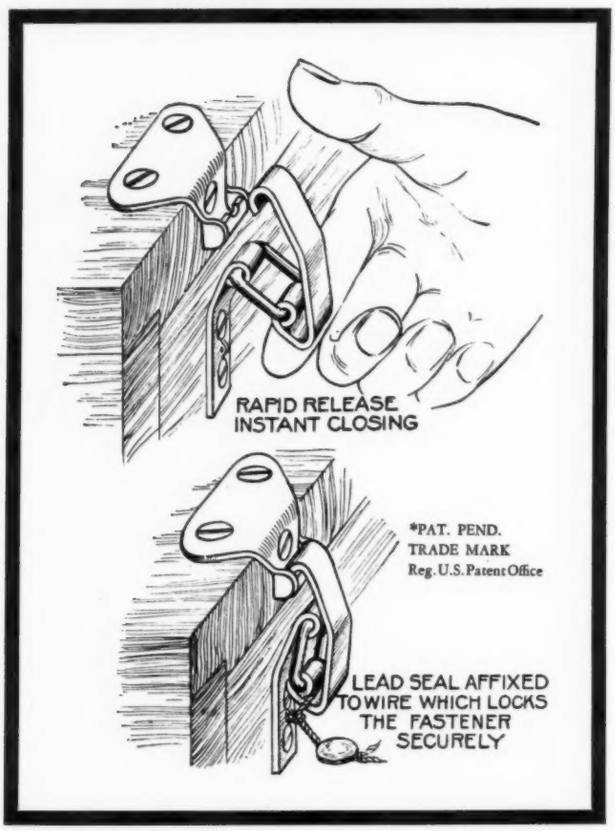
Elementary tactical training in formation flying with planes simulating attacks on bombers follows. The formations are of nine planes, and the attacks are delivered by three of the fast trainers, which usually come swooping in with the sun as a shield. The problem for the students is to keep the largest possible number of guns trained on the attack ships at all times without breaking formation.

A final written examination covering every step of the heavy curriculum follows. Those passing are qualified gunners. They are ready for transfer to advance tactical training stations, where they will train with bomber combat teams. Gunnery students must be between 18 and 30 years of age, inclusive. They must have at least an eighth-grade education and must pass the Army Qualification Test with a score of 100 or better.

if you don't
GET THE BEST OUT OF
YOUR AIR TOOLS . . .
wear will!
Every air tool in your repair shop is a production casualty! Yet uninterrupted performance is so easy and so sure . . . with automatic air line lubrication.
Use
NORGREN
Lubricators
They inject just enough oil into the air stream to maintain a fog that lubricates every working part of the air tool.
Automatic . . . work only when the tool works. Positive control, sight-feed. Wide range of sizes to meet every requirement.
CATALOG 400
C. A. NORGREN CO. DENVER COLO.

MAXIMLOK*
AMMUNITION
BOX FASTENER

U. S. GOVERNMENT DRAWING 76-0-47



The MAXIMLOK Fastener is simple and efficient.

Especially designed to streamline hardware for ammunition boxes.

Saves 60% of steel and 22 screws on each box.

Reduces the cost between 5c and 7c on each box, because of saving in labor and materials.

No cutting-in operations are required.

Rapid release and instant closing gives those extra vital seconds necessary in modern war.

Prevention of sabotage is another feature which assures the ammunition arriving safely.

The universal use of the "MAXIMLOK" on all ammunition boxes would save millions of pounds of steel per annum and many more millions of steel screws.

Specify Drawing #76-0-47 and help to accomplish this.

MAXIMLOK COMPANY
631 KENT AVE., BROOKLYN, N. Y.

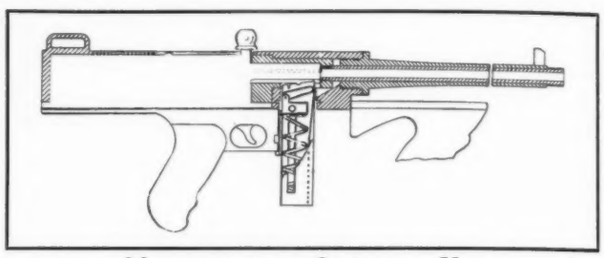
New Developments

Caliber .22 Conversion Unit for the Thompson Submachine Gun

Lieut. Col. Calvin Goddard

NUMEROUS elements of the military and naval forces of the United States are equipped with or use Thompson submachine guns, and others of the United Nations have units which employ these weapons. Invented at the close of the first World War, this arm saw little action except in the hands of law-enforcement agencies and U. S. Marines until 1939. Before the rearmament program got under way, there were only about 15,000 Thompson guns in existence.

The merits of this and other submachine guns are such that tremendous numbers of them have been produced during the last few years and specialized groups of all armed forces are equipped with them in large quantities. Since their cyclic rates vary from 250 to 600 shots a minute, the resulting fire power is enormous. This is a disadvantage when such weapons are in poorly trained hands since large quantities of ammunition are then consumed with little practical results.



Magazine of the Conversion Unit

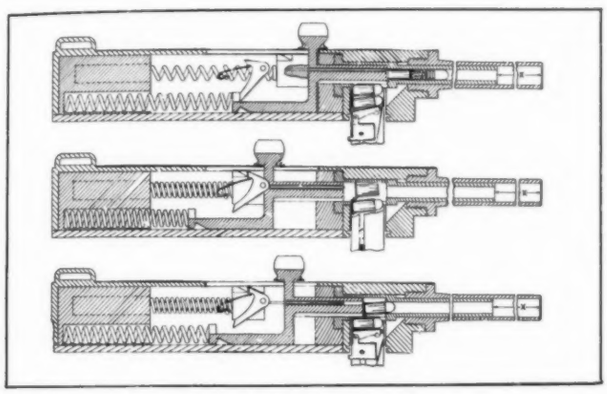
There is no royal substitute for actual experience in firing a weapon, no matter what the type. Electric and "trick" devices which use something other than cartridges for securing registered hits fail to fill this need. But the employment of smaller, less expensive (*i.e.*, subcaliber) cartridges which will produce effects in a measure similar to those of the standard ammunition for the arm under consideration appears to offer a satisfactory solution. Practice firing with many types of artillery is conducted with subcaliber barrels. Machine-gun training is carried out in part with .22 subcaliber guns which, while not performing in a manner exactly duplicating that of the .30 or .50, nevertheless fulfill a distinctly useful mission. They permit the retention of the external appearance and balance of the original weapon, combined with the delivery of full-automatic fire.

Several years ago, the .22 floating-chamber adapter for the Colt .45 automatic pistol was introduced, and with considerable success, since it permitted the change of a stock model service .45 automatic to caliber .22 by the ready substitution of a few parts. This device offers excellent training, with results approximating those achieved with the full-calibered arm, while not requiring the expenditure of the larger and more expensive ammunition and the attendant consumption of valuable materials.

A DEVICE serving a like purpose with respect to the caliber .45 A.C.P. Thompson submachine gun is now available, converting it to handle .22 long-rifle rim-fire cartridges without the use of special tools. The new device possesses certain advantages over other subcaliber adapters. Thus, the Browning machine gun, when converted to caliber .22, cannot be reconverted for use as a caliber .30 arm. This is not true of the conversion unit for

the Thompson as the gun is ready for use with .45 ammunition within a minute after the last .22 cartridge has been fired with the new device. To operate the Thompson as a caliber .22 weapon, the conversion unit is placed in the receiver of the caliber .45 gun after the bolt, lock, actuator, recoil spring, and buffer have been removed in the manner usually followed in cleaning these parts. Replacement of the frame in the engagement slots of the receiver completes the change-over process and the gun is then ready for use as a .22, capable of being fired full or semiautomatically at rates of fire possible with the standard weapon. An added advantage is that caliber .22 units can be used in *any* Thompson gun without alteration or damage to the arm.

Full advantage of the maximum recoil is taken through utilization of the portion of the caliber .45 barrel not occupied by the insert barrel as an expansion chamber which collects unburned gases and powder. The ultimate combustion and expansion of these add to the muzzle blast and induce a certain amount of "climb" on exit from the muzzle not ordinarily encountered with caliber .22 arms. Under sustained full-automatic fire this tendency is especially noticeable, while the recoil is such that a 12-gauge automatic shotgun recoil spring is necessary to retard the blow-back action of the .22 conversion-unit bolt. This device was invented by Charles William Robbins of Cincinnati,



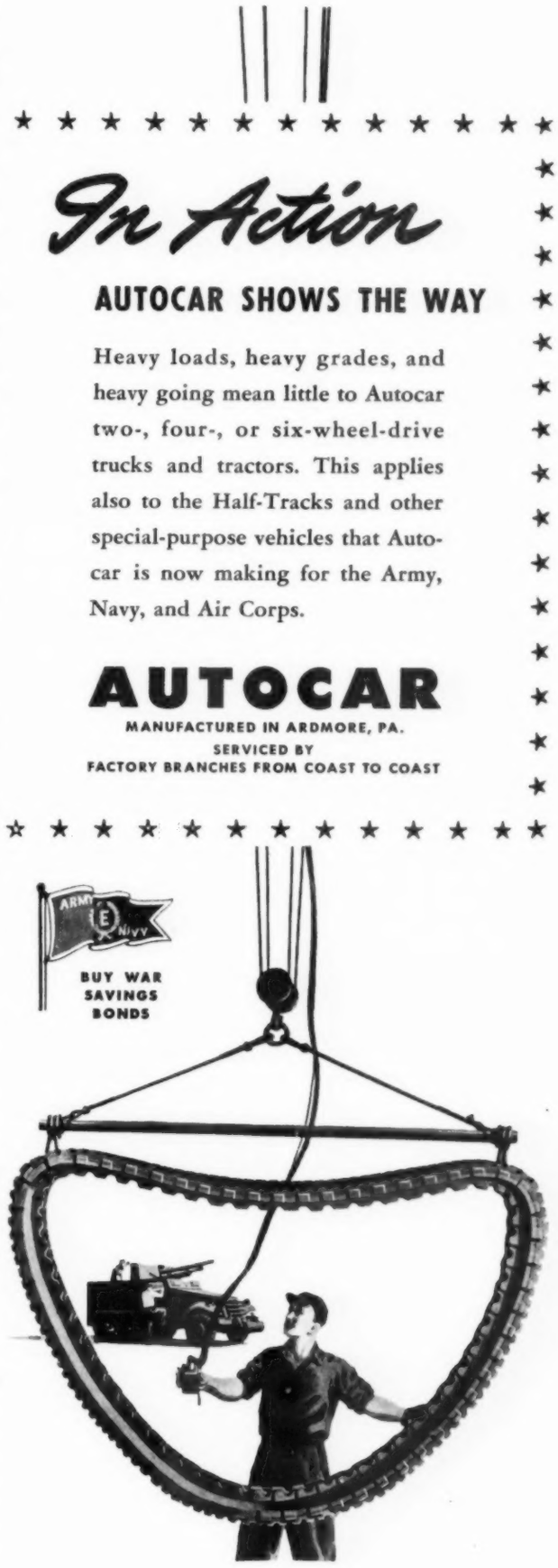
THE CONVERSION UNIT IN ACTION

Top: The device in the act of firing. *Center:* The fired case in process of ejection. *Bottom:* The device with hammer cocked and ready to fire.

Ohio, who maintains a small laboratory and shop for the study and development of arms with especial attention to subcaliber work. (EDITOR'S NOTE.—The following article on spark photography is by Mr. Robbins.)

The Robbins unit for the .45 Thompson submachine gun consists of five main parts; namely, .22 barrel, bolt, lock-frame, buffer, and magazine. After the standard gun is "stripped," the five unit parts are inserted from the bottom opening of the receiver through which the .45 parts are normally assembled; *i.e.*, the barrel is inserted in the same manner as the regular bolt, there being ample clearance to permit this once the original .45 parts have been removed. On insertion, a retaining ring strikes the receiver, fixing it securely in place and preventing it from rotating under the counterinfluence of the bullets' travel.

The bolt with firing pin and firing-pin spring is inserted between the sides of a lock-frame which supports them in operation and at the same time holds an additional sear. The latter assures the discharge of each cartridge since the firing pin is not released until a tripping lug at the rear of the bolt engages the added sear on the lock-frame. This takes place on final closure of the bolt which, as in the case of the regular .45 Thompson gun, is held in retracted or cocked position until the trigger is pulled. The buffer block is inserted behind the lock-frame after the latter has been positioned in the receiver, the recoil spring and guide are inserted in the buffer, and the forward end of the guide rod is then placed in the abutment at the rear of the bolt.


In Action
AUTOCAR SHOWS THE WAY
Heavy loads, heavy grades, and heavy going mean little to Autocar two-, four-, or six-wheel-drive trucks and tractors. This applies also to the Half-Tracks and other special-purpose vehicles that Autocar is now making for the Army, Navy, and Air Corps.
AUTOCAR
MANUFACTURED IN ARDMORE, PA.
SERVICED BY
FACTORY BRANCHES FROM COAST TO COAST
ARMY E NAVY
BUY WAR SAVINGS BONDS

For all types of neutral and cyanide hardening . . . for carburizing, brazing, tempering . . . for age-hardening, selective heating . . . and for hardening high speed steel tools . . . more than a thousand Ajax-Hultgren salt bath furnaces are used today, because:

1. Molten baths "control the atmosphere" by the simple process of eliminating it entirely. Hence scaling, oxidization, or decarburization cannot occur. No other heating medium possesses this valuable characteristic.

2. A salt bath is the fastest heating medium, and Ajax furnaces yield more completed heating cycles per day than radiation or forced convection systems.

3. Heating is uniform, hence distortion cannot occur. This is true because of the operating principle itself, and no other means gives automatic temperature control within such narrow limits (5 deg. F. or less).

4. Selective heating may be done at will in Ajax units.

If you have not yet investigated Ajax-Hultgren installations* send for Catalog 107-A.

AJAX ELECTRIC CO., INC., 911 Frankford Ave., Philadelphia, Pa.

*THERE'S AN AJAX INSTALLATION NEAR YOU

THE AJAX HULTGREN ELECTRIC SALT BATH FURNACE

SELF-STARTING • SELF-CIRCULATING

ASSOCIATE COMPANIES: AJAX METAL COMPANY, Non-Ferrous Ingot Metal for Foundry Use
AJAX ELECTRIC FURNACE CORPORATION, Ajax-Wyatt Induction Furnaces for Melting
AJAX ELECTROTHERMIC CORPORATION, Ajax-Northrup Induction Furnaces for Melting, Heating
AJAX ENGINEERING CORPORATION, Ajax-Tama-Wyatt Aluminum Melting Furnaces

New Developments

This completes assembly of the unit, the only remaining operation being to slide the frame onto the receiver and pull back the actuator knob on the .22 bolt until it engages the regular sear in the frame.

MAGAZINES are attached in the same manner as the regular 20-shot, caliber .45 type—through a lug at the rear which engages a slot cut vertically at the extreme front of the Thompson frame. Since the normal magazine well is partly filled by the barrel extension, the underside of this extension is cut out to form an opening through which the top portion of the magazine projects, bringing cartridges up into stripping position before the chamber. An opening cut on the right side of the extension mates with the regular ejection port of the Thompson receiver to permit ejection of the .22 cartridge cases. With the unit assembled and a magazine in place, the presence of the conversion device is revealed only upon close examination of the ejection aperture.

To simulate the appearance of the magazined caliber .45 Thompson gun, conversion-unit magazines must be rectangular in outline and vertically positioned since the standard .45 bolt strips the cartridges from the .45 magazine on a straight line into the long throat of the receiver, whence they eventually find their way into the chamber some distance ahead. The conversion-unit .22 magazine closely resembles the standard .45 type in size and shape, but its operation is unlike that of any other .22 magazine hitherto distributed since it successfully permits double-stagger loading of a large number of .22 rim-fire cartridges, one upon another, with bases abutting on a vertical plane. Unlike ammunition of .45 A.C.P. caliber and many other "rimless" types in which the base is of essentially the same diameter as that of the case, the rims of .22 rim-fire cartridges are appreciably greater in diameter than their respective cases, thereby rendering impractical the use of the types of magazines commonly employed with rimless varieties.

The main difficulty in loading large numbers of rimmed cartridges one on another lies in their tendency to form an arc, the curvature of which increases sharply with the addition of each layer. Usually when their bases are disposed in contact with a vertical plane and they are fed while lying at right angles to the rear face of the magazine in quantities of more than seven they jam when impelled upward by the platform and lifting spring. This difficulty was previously eliminated by employing not more than seven cartridges or by curving front and rear magazine walls to conform with the arc formed by a stack of more than five rounds (*e.g.*, the Winchester Model 52 bolt-action rifle).

Self-loading pistols of the .22 variety are commonly supplied with 10-shot magazines the frames or shells of which are rectangular in outline. The flat rear interior face of the frame lies, however, by no means parallel with a line drawn through the centers of the heads of the cartridges contained within. As a result, as these move upward they traverse a path which is curving with respect to this rear face, the lowermost point of the head of each case riding upon the top surface of the case immediately below at a point considerably *forward* of the head of the lower cartridge. Thus the tendency to jam is overcome. The platform or follower has a corresponding angle worked into its upper surface which, while it travels in a straight line, maintains the approximate 45-degree tilt which the cartridges assume in this type of magazine.

THE magazine well of the Thompson receiver is not sufficiently large to accommodate a magazine such as that just described for pistols, while the curved variety cannot be used if similarity in appearance between the standard magazine and that of the conversion unit is to be maintained. The conversion-unit magazine embodies a special platform or follower designed to present the top cartridge in proper position for feeding at the exact angle

New Developments

required for trouble-free insertion into the chamber by the forward movement of the bolt and yet maintain a constant jamless elevation of all the remaining cartridges. The follower has a member pivoted at its rear which is free to rotate in a vertical plane and so to alter its angle with the rear face of the magazine box, just as the forward ends of the cartridges in the stack alter their angles in relation to the plane of that face as their rims force the rear end of the stack lower while the forward ends of the bullets tend to tilt upward at an ever steeper angle.

There is a vertically disposed guiding face on the interior of the front member of the magazine shell which conforms in contour with the arc described by the bullet ends of the cartridges and serves to control the downward or upward movements of the rotatable component of the platform, the front end of which, by bearing against this face, follows a path directly corresponding to the changes which take place in the contour of that arc upon the addition or subtraction of each cartridge. As the regular follower moves upward under the influence of the magazine spring, the rotatable member tends to move down in a clockwise direction under the influence of the cartridges resting on it, but the angle of inclination of the free part of the platform is at all times dependent upon the relative location of the whole magazine follower to which the platform is pivoted.

Thus the angle of lift of the platform is automatically adjusted to compensate for the inclination of the cartridges as they are intermittently presented to the stripping lips. These lips are wide enough only for the passage of one cartridge at a time from a double-stagger stack which begins about half an inch below the top of the magazine box. The gradual taper made by drawing in the upper ends of the box automatically separates the top cartridge from each side of the stack alternately in such a fashion that succeeding rounds push this immediately into stripping position. At the same time, the inclination of the platform is such that the rims of adjacent cases do not bear on each other or interfere with the proper stripping of the uppermost.

The magazine shell is slotted on both sides to permit protruding serrated buttons attached to the platform to be grasped to aid in depressing the latter during loading. A lug on the platform projecting through the rear of the box travels in a vertical slot, permitting its engagement with the tripping device of the regular Thompson gun which locks open the action with the last shot. Designed originally for police practice, Mr. Robbins' device appears to possess possibilities for the military as well.

Simplified Spark Photography

C. William Robbins

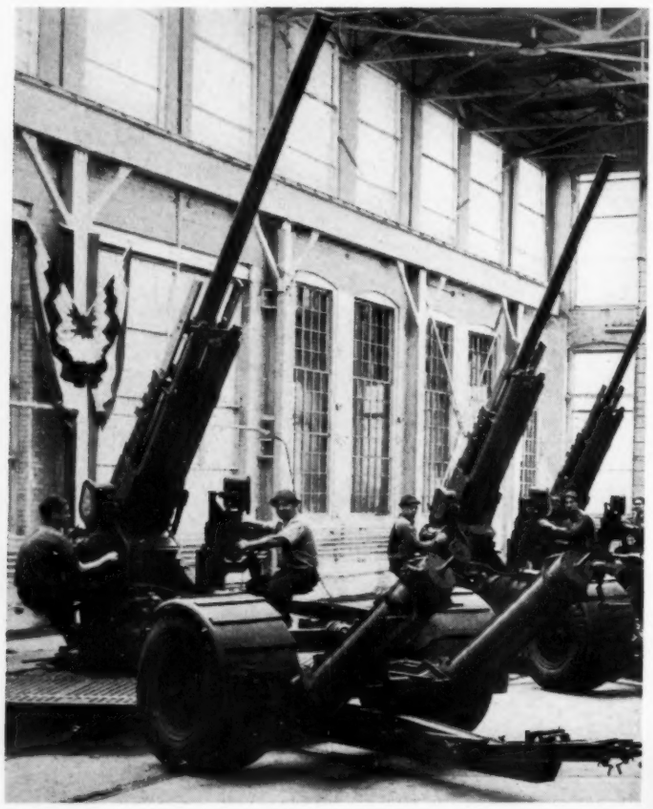
An interest in target shooting combined with the desire to know just what transpires after the bullet leaves the barrel, plus curiosity as to the causes of its subsequent activities, recently led two experimenters, Don Winget, Jr., and Arthur Paul Young, both electrical engineers of Cincinnati, Ohio, to undertake the design of a simple and inexpensive apparatus for spark photography. Knowing that the speed at which the average bullet travels would necessitate the employment of an illuminant intense in type and of extremely limited duration, they found that an electrically discharged spark would best satisfy these requirements. A trip to a commercial ammunition manufacturer's ballistic laboratory and observation of methods there employed for taking spark photographs showed that while these were satisfactory for the purposes at hand, they were not applicable to their particular problem. For they were aiming to produce a device which would combine simplicity, compactness, portability, and low initial cost—characteristics not possessed by the apparatus found in the laboratory visited.

Needless to say, this was a large order, and considerable

VITAL OPERATIONS

Among today's most vital operations are the construction of powder and shell-loading plants, airports, military highways, barracks and cantonments. And—today's most reliable tractor, **Cletrac,** will be found on the most important of these vital jobs. **Cletracs** are built in sizes from 14 to 96 H.P. on the drawbar, gasoline and diesel.

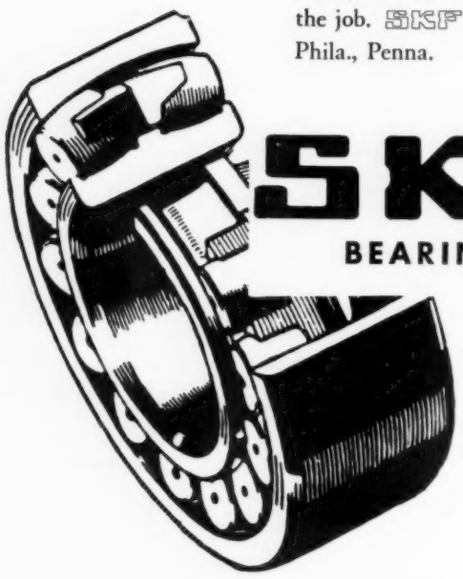
THE CLEVELAND TRACTOR COMPANY
CLEVELAND, OHIO



ON THEIR WAY

One after another, these 90-mm. AA Guns are leaving arsenals to command the skies. And with them are SKF Ball and Roller Bearings in command of revolutions on vital rotating parts. Where the need is for dependability, SKF's are always on the job. SKF Industries, Inc., Phila., Penna.

5206



SKF
BEARINGS

New Developments

thought and experiment had to be devoted to its proper execution, but success finally was achieved in the simple but effective "sparkograph" machine described below.

This was constructed in a little over four weeks, following a 5-week consideration of its design. The machine as finally evolved proved sufficiently compact to be readily portable in a small suitcase since its power supply is completely self-contained and independent of external aids.

The "sparkograph" consists of a case containing all the elements of the machine proper. Power is derived from batteries contained in the bottom of the case itself. Connected to these is a series of condensers which are charged individually by a manually operated rotary switch which wipes past the contact of each condenser as it revolves. As the charging is completed, the switch automatically becomes disconnected and inoperative, thus preventing recharging until the energy stored within the condensers has been released. An instantaneous relay of special type designed by Winget and Young is wired into the circuit and at the emergence of the bullet is disconnected by the breakage of a wire stretched across the muzzle of the gun or by other means to be described later.

Upon disconnection of the relay, a spark of nearly 12,000 volts is discharged in a specially designed "spark pick-up" or "spark-gap" container, so constructed as to prevent contact of the electrodes by any human agency. The light, which emerges through

Fig. 1. Spark Photograph of a Bullet in Flight—Arrow Shows Beginning of a Sound Wave

a small opening at one side of the insulated gap container, is of extremely high intensity, since its illuminating value at the moment of discharge is estimated to be about one hundred times that of the sun. Although the duration of the discharge is probably not more than a ten-millionth of a second, the entire field near the gun's muzzle is lighted sufficiently when the spark emerges from the gap in surrounding darkness to permit the human eye readily to perceive the bullet leaving the bore and commencing its flight. The bullet stands out in bold relief against the background which usually consists of white or light-yellow paper placed along that portion of the bullet's path which will be within range of the spark.

The expense involved in the period of development was assumed by a radio manufacturing company since that organization felt it might find other uses for the device. This expectation was justified when Winget and Young discovered that the "sparkograph" could be used in broadcasting studios in the study of sound effects during the presentation of programs. Blank cartridges were loaded to give pressure curves corresponding to those of ball cartridges, and numerous tests were made. It was found that sound waves could be recorded visually by this spark method as easily as though they were solid objects. The many potential uses of the instrument are just now being unfolded, for it can be adapted for recording the activities of a multitude of objects traveling at high speed, such as motors and sound devices, as well as projectiles. Highly pertinent is the relatively modest cost of the device which duplicates and in some instances surpasses the work of large laboratories whose equipment does not embody like advantages of compactness and portability. The average mechanically inclined person could purchase the necessary parts for about fifty dollars and produce the machine in a small shop.

The actual photographic "stopping" of bullets in flight is

New Developments

undertaken only after firing a series of test shots with the gun under trial so as to estimate the probable positions of the fired bullets with respect to the muzzle of the piece when the spark discharges are released. Every effort is made to maintain constancy with respect to the position of the gun, speed of discharger operations, and character of ammunition employed so that the predetermined points for location of the camera or photographic film will be correct. As previously stated, the human eye can "catch" the bullet in its flight and therefore judge its probable position with the set-up outlined. When this has been determined, the film is put in place (in darkness of course), the gun fired, and the bullet's flight recorded.

Exposures are made in darkened surroundings since the sharpness and definition of the bullet are greatly accentuated by this method. The film employed is of the high-speed type sold at photographic supply houses and is of standard make. It is placed in a camera equipped with a very fast lens and the shutter opened prior to the spark discharge. Following this, the shutter is closed and the film preserved in the usual manner. The camera may be discarded, and the film alone placed in the position previously estimated and parallel to the line of flight of the bullet but on the opposite side, resulting in a "shadow picture."

The method of discharge is usually chosen after full consideration has been given to the arm and its ballistic properties. In some cases, the simple muzzle-wire method is used. This consists

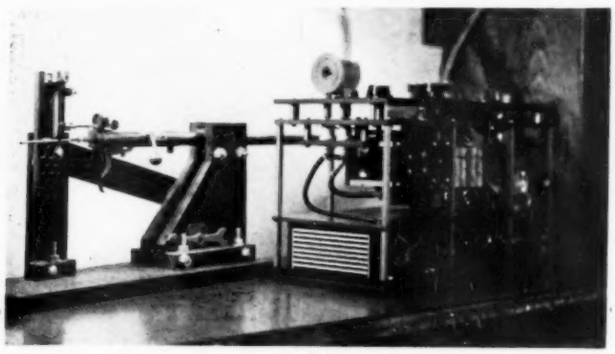


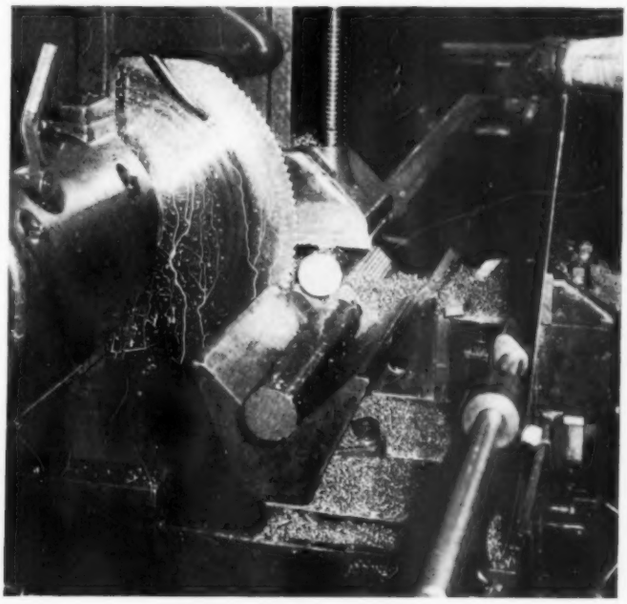
FIG. 2. THE "SPARKOGRAPH" REMOVED FROM ITS CASE

of stretching across the muzzle of the gun a wire which is broken by the passage of the bullet. This in turn breaks the flow of current through the wire which forms part of the circuit of a relay, permitting the latter to open and discharge the spark. Another method involves the use of an audio-discharger. This embodies a container to which is attached a thin sound-sensitive diaphragm. When the gun is fired, the resulting report disturbs the diaphragm to the center of which is attached a small metallic spot connected to one end of the relay circuit. Against the diaphragm spot rests a tiny contact piece free to move backward and attached to the other end of the relay circuit. As the report of the gun causes the diaphragm to vibrate, the contact spot is pulled away from the inner contact piece which breaks the circuit and opens the relay, thus discharging the spark.

Figure 2 illustrates the spark machine as removed from its case. The "spark-gap" can be seen in the middle of the "sparkograph" cover while the batteries which provide the power supply are in their position on the under side of the assembly. At the left is a gun barrel attached to its discharge cradle with the mechanical circuit breakers resting against the rear of the bolt. Figure 1 shows the muzzle blast of gas following the exit of the bullet. It is this mass of gas which produces the disagreeable factors sometimes encountered in shooting. In this particular instance the barrel was sufficiently long to permit full consumption of the combustible gases before they escaped from the muzzle. The arrow shows the beginning of a sound wave.

ATKINS

Curled-Chip TEETH



FOR *Sustained* HIGH SPEED METAL CUTTING

● Industry's great drive to achieve uninterrupted high speed production is giving many new tools and new techniques their first real "baptism under fire." Among the tools giving an excellent account of themselves are Atktins "Curled-Chip" Saws for high speed, heavy duty metal cutting.

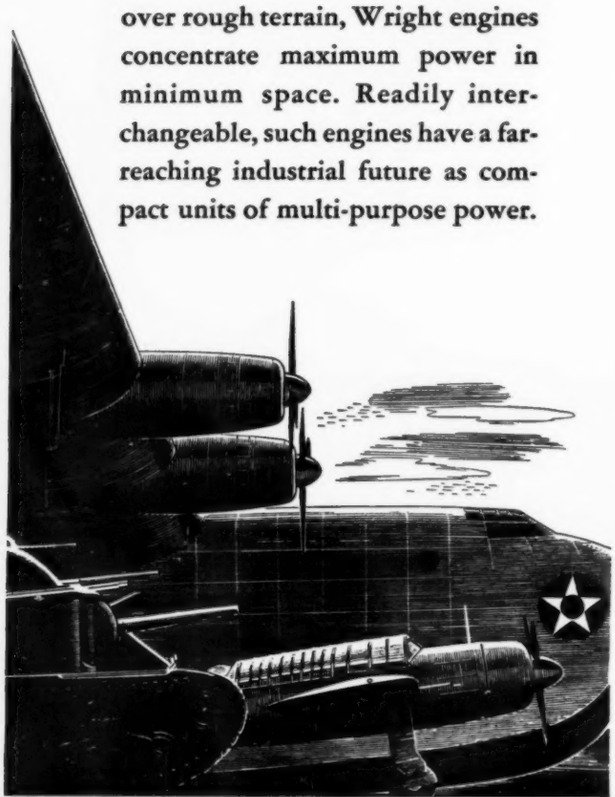
A new tooth design—one that removes metal in continuous chips jumping clear like likely clocksprings—has brought about hitherto unattainable cutting rates . . . more square inches of cutting between servicings . . . conservation of valuable power—in brief, *sustained high speed metal cutting.*

To help armament plants achieve and maintain peak efficiency on metal cutting work, our engineering department is ready to work closely with production men in getting the right saw on every job.

E. C. ATKINS & COMPANY
443 S. Illinois St., Indianapolis, Indiana

Multi-Purpose
POWER

WHETHER they carry the tonnage of huge bombers, speed hard-hitting fighters or hurl heavy tanks over rough terrain, Wright engines concentrate maximum power in minimum space. Readily interchangeable, such engines have a far-reaching industrial future as compact units of multi-purpose power.



WRIGHT
Aircraft Engines
THE POWER FOR TONNAGE TRANSPORT

From the Record

Iron Production and Victory

GERMANY produces normally some ten million tons of iron ore a year. Seven European countries which Germany has occupied or controls produce normally some forty million tons. We can be sure that those seven countries, whether occupied or controlled (and there is little to choose between the two), will not yield normal production. . . . The miners are not getting enough to eat to put in a regular day's work . . .

Japan's annual steel capacity, to the best of our knowledge, is some seven and a half million tons. She has seized some usable, but not large, iron-ore deposits in the Philippines, the Malay Peninsula, Burma, and Indo-China. She is faced with a difficulty of transport which Germany does not have to worry about—American bombing planes and submarines are not making the job of delivery any easier. Germany's only overwater imports are from Sweden, where she is getting from twelve to fifteen million tons a year. Altogether, the Axis powers, counting in the occupied and controlled countries, have an estimated production capacity of seventy-four million tons of steel ingots a year.

The capacity of the United Nations is more than twice that. But capacity to produce and actual production are different things. If that capacity could be speedily translated into tanks, guns, shells, and airplanes, it would, of course, appreciably shorten the war. It can, and will, spell the difference between victory and defeat. . . . The stuff is in the ground; it's a matter of getting it out. . . . The question of how long this war will last is in the hands of the American miner.—*Robert P. Patterson, Under Secretary of War, to the iron miners of Negaunee, Mich.*

Free Discussion in War Time

WE ALL know that there can be no higher form of efficiency than the voluntary coöperation of a free people. In peace time, this coöperation can be assured by full discussion and, where necessary, by compromise to secure agreement and harmony. In war time, this desirable full discussion is necessarily handicapped by the requirements for military secrecy. The Army and the Navy are very much on the spot at the present time. Numerous commentators, many of our political figures, and a great number of "armchair strategists" are exerting a very great influence on the public's opinion of how the war is being fought. Unfortunately, none of these spokesmen are acquainted with all the facts, certain of which must necessarily remain military secrets...

Nothing would please the Army and Navy more than the opportunity to tell the American people the whole story and to repudiate the half-truths and superficial observations which are now being circulated in such abundance. Were the Army and Navy to yield to the very tempting prospect, the success of present and future operations would be jeopardized and the lives of our soldiers and sailors would be endangered.—*Lieut. Gen. Joseph T. McNarney, Deputy Chief of Staff, U. S. Army, in an address at Emporium, Pa.*

Springfield Armory

SPRINGFIELD Armory is no mere factory. It was founded by direct order of Gen. George Washington; it has never once in its long history failed the United States of America; it is now more victorious than ever.

In the heat of a losing battle on Bataan, General MacArthur took time to cable the War Department in Washington that our

M1 rifles were performing with excellence and distinction. Each of you should feel that General MacArthur sent that message to you. Newspaper reports state that captured Japanese soldiers inquire how America is able to arm every American soldier with a machine gun. These aren't machine guns—they are M1 rifles!

Springfield rifles have marched in many a campaign, have fought in many a battle. With toughened soldiers, with salty sailors, with leatherneck Marines, they have won their laurels. That places *us* close to our fighting men. Although we may never be side by side with them in the fight, the skill of our hands, the products of our machines are carried to the forefront of battle—to our own boys, our brothers, our cousins, our friends. If we who are behind the lines fail the men in the lines, they die and we become slaves—a fact no one who reads the news can miss. The strength of our battle front is determined by the production front.—*Col. Earl McFarland, Commanding Officer, Springfield Armory, at presentation of Army-Navy Production Award.*

The Spirit of America

WHEN the Redcoats marched through Lexington on April 19, 1775, the men of Lexington knew what to do. They grabbed up their hunting guns and stood assembled on the town commons. And they stood there—sixty men facing an army of trained soldiers. That took *guts*. And something kindled there on that Lexington green—something that has grown through the years—a flame of courage, the American spirit. It's something that gets down deep inside of you whether you came from Cape Cod or Copenhagen, from Brooklyn or Belgrade, or Moscow or Warsaw or Munich. It's a deep inner feeling that's made up of the hopes of all people wherever they come from. It's a dream that here in America, if ever, is where the common man has a chance—away from the hatreds and injustices of the Old World.—*Editorial in the "Flat Tire," employee publication of the Fort Crook Ordnance Motor Base, Nebr.*

American Aircraft in Battle

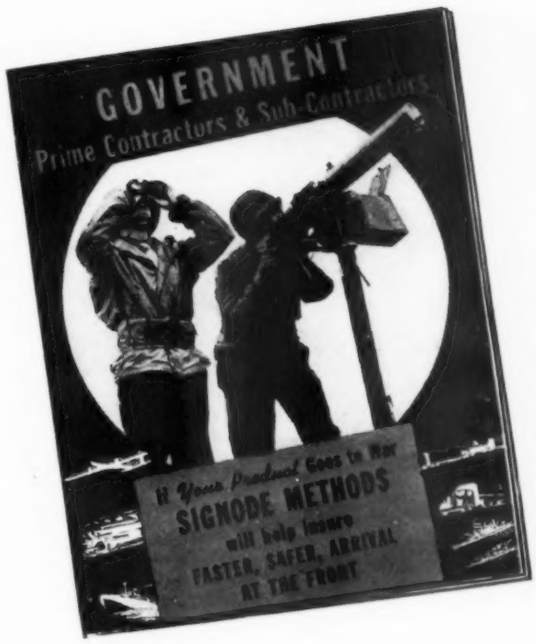
IN THE Pacific, our Flying Fortresses have proved themselves . . . And now, after only a brief training period, they are showing their mettle in Europe. I mention the Flying Fortresses especially because other types of American-made bombers have, long ago, won the affection of the British and the respect of the Germans.

In a recent issue of a London newspaper I read a summary showing that, in July and August, Flying Fortresses made more than 100 daylight attacks on German positions without the loss of a single plane. I dare say that no other bomber has such a record in Europe. Not only that, but in the course of these attacks the Fortresses destroyed or disabled close to a dozen of Germany's newest air weapon, the Focke-Wulf 190 fighter. Last, but not least, these attacks, all carried out at very high altitudes, prove the soundness of the American high-altitude bombing theory. When our Flying Fortresses reach their targets, they hit them again and again.

Some of the self-styled home-made aviation experts are making much ado about the fact that American pilots are flying Spitfires in England. They gleefully say that this is proof that our fighter planes are inferior to the British. Nothing could be further from the truth. There are two main reasons why we fly Spitfires in England. I'll give them to you briefly.

One is that the British production of Spitfires is so rapid that you might almost say that there is a Spitfire behind every bush in England. So why ship pineapples to Honolulu, especially when our fighter planes are badly needed elsewhere on more than seven other fronts on all continents? Another reason why we are using Spitfires in England is because the Spitfire is well suited and has been built especially for the type of action it is called upon to perform—a fast-climbing interceptor for the defense of England against air invaders, where it is not necessary to have the range required on other fronts.—*Capt. E. V. Rickenbacker before the San Francisco Chamber of Commerce.*

SIGNODE SYSTEM OF STEEL STRAPPING



Get This New Bulletin!

ON WARTIME SHIPPING

★

Write for it Today

★

Shows Methods and Tools Widely Used for Safe, Fast Shipment of Vital Ordnance Materials, Ammunition, etc.

This new bulletin shows how government prime contractors and sub-contractors are using scientific Signode loading methods to assure "on time" delivery of shells, truck bodies, airplanes, inert bombs, life rafts and other vital war products. Also illustrates the Signode Tools used for safe application of Signode Steel Strapping. *Send for it today.*

SIGNODE STEEL STRAPPING CO.
2656 North Western Avenue, Chicago, Illinois
Brooklyn, N. Y.: 389 Furman Street
San Francisco, Calif.: 475 Bryant Street
Representatives in Principal Cities Throughout the United States and Canada

SIGNODE 25 Years of Packing Improvement

Steelcrete

EXPANDED METAL
Saves STEEL

The Steelcrete system of cold-drawing sheet steel into Expanded Metal produces maximum strength with minimum weight. Steelcrete Expanded Metal is especially adapted for:

Tanks
Trucks
Traction Mats
Landing Mats
Shell Cases
Tool Boxes
Plane Parts

"The entire facilities of one of our plants, which has been especially designed for the fabrication of light plate, sheet metal or expanded metal products, have been assigned to the production of war items. We solicit your inquiries on either job or production type business."

OTHER Steelcrete SAFETY PRODUCTS

SAFETY GUARDS for Men and Machines
SAFETY GUARDS for Windows, Doors, Conveyors
REINFORCING MESH and WELDED WIRE FABRIC for Concrete

Literature Upon Request
"IT'S WHEELING STEEL"

THE CONSOLIDATED EXPANDED METAL COMPANIES
WHEELING, WEST VIRGINIA
Quick Shipments from 14 Warehouses

Book Reviews

LEE'S LIEUTENANTS—A STUDY IN COMMAND (VOL. I: MANASSAS TO MALVERN HILL). By Douglas Southall Freeman. New York: Charles Scribner's Sons. $5.

TO thousands of grateful readers of Dr. Freeman's magnificent work on Lee, the mere fact that the same writer has now published the first volume of a new study of the Civil War is sufficient inducement for them to hasten to obtain it. But to those few students of history who were so unfortunate as to miss "R. E. Lee," and to the many who might be tempted to think that the present hectic period of world conflict relegates such a work to the limbo of lifeless things, to be taken up only in more leisured times, this reviewer appeals for a reconsideration.

Probably no conflict in all history is of as great value to the student of modern warfare as is the war of 1861-1865. First in history to see the general use of rifled arms, of railroads, and of field fortifications, it raged over extensive ground, and combined the use of masses of men under many veteran officers on several widely separated fronts. Surely it was not chance which led the German general staff to concentrate for years on the study of our Civil War, nor was it chance that led such men as Marshal Rommel to spend months on the fields that were the scenes of its campaigns. And now that the British commanders are so ably forging ahead, it seems but reasonable to assume that the teachings of their great writers, such as Henderson and Maurice, form a considerable part of their reawakening.

Douglas Southall Freeman is a newspaper editor of note, a holder of the Pulitzer prize, and a master workman. To him, nothing but the best that is humanly attainable is to be considered. Faced with the very grave difficulties of writing a book which was to be substantially a biography of some dozen soldiers who often participated in the same actions, and with extensive notice of many others, he was forced to evolve a fundamental plan of construction which would obviate a constant repetition of the same fields, as seen by the various leaders. Likewise to be avoided was a too-close parallel to his life of General Lee. The method which Freeman finally evolved, and which he so clearly explains in his foreword, is full of difficulties for the author, but they are not even glimpsed by the reader. As in his previous works, his flawless English and the smoothness of his construction is so noteworthy, that, paradoxically, one enjoys, though he scarcely notes it. The very considerable use of the "cut back" and the "jump," which is necessitated by the many actions and personalities which so constantly play upon one another, is so admirably handled that the reader is not conscious of interruption in the flow of the main theme.

At the very beginning there is presented a series of thumbnail sketches of some thirty-five of the characters who are to play a part in this volume—forming an easy and effective means of preparing the mind for full appreciation of the pages to follow. "Lee's Lieutenants" gives, of course, a splendid picture of the Army of Northern Virginia, its deeds, and the political background which unfolds as the conflict progresses. But though the depth of the author's knowledge of the war as a whole is in ample evidence, it is to the character of the men who either rose to command or gave promise of doing so that Freeman gives the full measure of his energy.

Those who admire Dr. Freeman for his objective treatment of any subject he approaches, will not be disappointed. He "hews to the line, let the chips fall where they may." Just as he never hesitated to criticize General Lee when dealing with that commander, so does he dismiss as unworthy more than one figure

of note and fame, and does not falter at a weighty reappraisement of "Stonewall" Jackson—next to Lee the greatest of the Confederate paladins. This new appraisal is sound; though Jackson's reputation as an army commander suffers in not inconsiderable degree, the criticism is thoroughly factual. Neither in this, nor in any other case, is the slightest taint of "debunking" allowed to cheapen the author's work.

All in all, "Lee's Lieutenants" is the greatest historical biography of the past year. Its almost encyclopædic profundity is amply balanced by its splendid readability, and its value to the advanced student of high command, as well as to the general reader, is unquestionable. F. W. F. G.

ATTACK. By F. O. Miksche. New York: Random House. 267 pp. $2.50.

MAJOR MIKSCHE of the Czechoslovakian Regular Army fought in Spain as an artillery and staff officer at the headquarters of the Spanish Republican Army. This book is his notebook, written by a soldier, an amateur author, who knows whereof he writes, and tells convincingly of the new (?) warfare. "A real tactician fights always with both shield and sword, alternately or simultaneously. This book is an effort to describe the modern sword—the *Blitz* attack—and the modern shield of web defense." With these words the author ends his book and thus aptly describes its content.

Clausewitz taught his disciples first to divide the opposing forces, then to destroy each singly, one after the other. This is the "secret" weapon of the Axis; political infiltration, attack with its favorable condition of selection of field of action, surprise, speed, and superiority of matériel or fire power are the elements. Spain was the test tube in which Hitler tried out the modern conception of the ancient rules of war. Russia followed these lessons carefully. France did not and was either unconvinced or indifferent. Infiltration, concentration of tanks, dive bombing, planes used in close coöperation with ground forces are familiar to us now, but these were all tried out in Spain for the benefit of those who cared to learn therefrom.

The *Blitz* attack is based on the idea of thrust-point and pocket tactics. Motorized infiltration, which the author terms "irruption," attack on narrow fronts with tremendous speed and punch, break-through at a weak point, side thrusts after break-through to protect the flanks of the advancing units, and spreading into the enemy's rear creating havoc, are elements of the *Blitz*. It sounds simple, but the "ability to foresee comes not from common sense, but from doctrine, from theory, from understanding."

Initiative, surprise, speed, ability to compensate at times for lack of superiority in matériel, and ability to demoralize and disorder the enemy are basic. Clausewitz taught: "March separately, strike together." Narrow fronts, several of them, piercing the enemy lines with speed and punch, and pincers movement in the rear against the defense are the modern adaptations of this teaching.

The mobility of aircraft, its use as artillery, and the ability of aircraft when so used to aid in the element of surprise by masking its movement until it strikes, together with its value in reconnaissance, protection, liaison, supply and support, bring it to the front as a principal arm. The *Panzer* divisions must be linked to the air arm. Infantry and artillery are not elastic enough to adapt themselves in fire and movement to the speed of tanks. Tanks are no longer the technical surprise, they are "the *tactical* surprise of the war."

War today is made up of numerous small actions involving combat teams. The infantry does not exist in units larger than a platoon, and its work formerly done under outmoded forms of warfare is now done by combat teams of combined arms. The tactics of "space and gap" as differentiated from the tactics of the line or continuous front are used. Decentralization of artillery is tactically necessary and sound for many reasons.

Stuart Oil Products
Commandos of Industry!
Stuart's Thred Kut
HEAVY DUTY CUTTING OIL
Recommended by America's leading machine tool builders
Stuart's SOLVOL
LIQUID CUTTING COMPOUND
For carbide tools and where an "aquamix" solution is recommended
Stuart's CODOL
LIQUID GRINDING COMPOUND
Meets every test for the ideal Modern Grinding Compound
Stuart's "SUPER-KOOL"
AMERICA'S FIRST TRANSPARENT CUTTING AND DRAWING OIL

STUART OILS have led the attack on tough metal working problems for many years. Take advantage of the experience behind them and, without allowing superficialities to interfere, study your cutting fluid applications with the help of Stuart Oil Engineering Service.

For all cutting fluid problems

D. A. STUART OIL CO.
LIMITED

Chicago, U.S.A. • Est. 1865

Warehouses in All Principal Metal Working Centers

CUMMINGS
MACHINE
WORKS

—

Builders of
Precision Instruments

—

Established 1881

—

9-11 Melcher Street
Boston, Mass.

Book Reviews

The author covers many chapters with titles such as "Islands of Resistance," "Principles of Defense," "Counter Blitz," "Web Defense," and others which detail the workings of the new warfare. He has presented these in the homely, blunt, dry, simple manner of the soldier who has experienced modern war and has remembered what he observed. "Armies that adopt the correct tactical doctrine will live; those that adopt or slowly adapt the traditional forms will die." T. K. V.

STRATEGIC MATERIALS IN HEMISPHERE DEFENSE. By M. S. Hessel, W. J. Murphy, and F. A. Hessel, with a section on petroleum by Harold J. Wasson. New York: Hastings House. $2.50.

THE terrific import of the supply of raw materials or their substitutes to all the powers engaged in this global war cannot be questioned, and the significance of any book which adequately deals with this problem must appeal to every American. Numerous volumes on the topic, of both the technical and popular types are now appearing. "Strategic Materials in Hemisphere Defense" is a happy blending of the two. It is written by competent chemists, and their work is not weakened by too free a use of the popular style; yet they have kept technical terms at a minimum.

This reviewer has enjoyed comparing the present volume with Brooks Emeny's "Strategy of Raw Materials," which was regarded as the standard work on the question in 1934. Though Dr. Emeny's use of a standard system of charts is undoubtedly superior, the use of the narrative form by the present authors, aided by charts and tables, adds to the readability of their book. The eight years difference in the publication dates of the books gives an amazing advantage to the later work. Not only is this true in the kaleidoscopic changes in available sources of raw materials and in the great development of synthetics, but in the appreciation of the enormously increased needs of war.

At the outset of their book, the authors launch into the consideration of those two materials, rubber and tin, the loss of which has presented the gravest of all challenges to our war production. Possible sources, substitutes, synthetics, savings, etc., are exhaustively and interestingly treated; then steel and its alloys, and the minerals, fibers, and drugs which are considered the most critical for our war needs. Part II is devoted to a consideration of Central and South America as sources of supply. Reverting to materials, the less critical, such as chemicals, oil, fats, and domestically produced metals, are assessed. The conclusion is an excellent compendium of our world position and a frank warning to the American people that, despite our wealth of raw material, our technical skill, and our great productive capacity, we must extend ourselves to the uttermost if we are to attain victory in this war of survival.

The joint authors are to be commended for the successful manner in which they have steered their course between the dangers of overoptimism and discouragement. Quite factual throughout, the volume is a worth-while contribution to America's ever-increasing determination to win not only final, but complete, triumph. F. W. F. G.

THE GUILT OF THE GERMAN ARMY. By Hans Ernest Fried. New York: The Macmillan Company. 426 pp. $3.50.

OF Austrian birth and a resident of European countries from 1905 until his removal to the United States in 1938, Dr. Fried, now research associate on the graduate faculty at the New School for Social Research, New York, has had ample opportunity to study the growth of present-day German militarism and National Socialism. In his present volume he undertakes to adduce proof that upon the former, rather than the latter, lies responsibility for the cataclysm which now engulfs the world. And a very convincing mass of material does he present. "The responsibility of

Book Reviews

the new 'National Socialist' type of German militarism . . . is not that it was out for millions of new subjects, or thousands of square miles, or foreign markets, because it was never primarily out for these things. . . . This militarism was determined to establish the supremacy of its own military type over an entire civilization.

"German history between the two World Wars has largely been the history of the execution of a great bargain. The National Socialist Workers Party was the agent which delivered the German nation to the army. Hitler expressed the deal in these words: 'The party hands over the nation to the army; and the nation hands over the soldiers to the army.'

"The nation, of course, first of all had to be handed over to the party. The transaction was accomplished by a tremendous political pincer movement. Germany was squeezed between the conspirators from above, including, first of all, the military leaders and those related to them ideologically, socially, and by family ties; and the rebels from below who, with sovereign unscrupulousness, used whatever slogan was popular in order to undermine the world of the Kellogg pacts."

This is a thoughtful work, well executed and carefully documented. The thirty-four pages of notes with which it concludes embody almost 400 references to the text preceding, followed by six tables bearing upon the retired pay and allowances, civil status, and occupational activities of Imperial German Army officers in the interval between World Wars I and II. Whether or not the reader be prepared to accept all of Dr. Fried's conclusions, he cannot but admire the masterful manner of their presentation. C. G.

FOR PERMANENT VICTORY. By Capt. Melvin M. Johnson, Jr., and Charles T. Haven. New York: William Morrow & Company. 246 pp. $2.50.

EMORY UPTON'S "The Military Policy of the United States" is a work of incalculable value to the student of American military history. But, to this reviewer at least, his style is involved and his book, despite its vast import, difficult to read. No such criticism can be directed toward Johnson and Haven's latest contribution. It fixes and holds the attention from the beginning and tells in gripping words the familiar story of how, from Bunker Hill and Bladensburg to Pearl Harbor and Bataan, we have persistently cultivated the habit of "too little and too late." In spite of ourselves we have managed, thanks to a kindly Providence, to come out winner in the 111 wars, great and small, in which America has engaged since 1776. Now we are enjoying a new, and terrifying, experience. For despite lusty breast thumpings and loud proclamations of the certainty of victory, there persists the horrid thought that this time Providence may perhaps be difficult to woo—may even decide, perish the thought, to cast her lot with the enemy!

There are a great many smug pacifistic demagogues in the United States (and elsewhere) who should be sentenced to have a copy of "For Permanent Victory" chained about their necks until the present cataclysm ends and to memorize the work from cover to cover. For Messrs. Johnson and Haven have shown with bitter clarity the inevitable result of too much dependence upon Providence and too little upon an ample supply of dry powder.

If America wins this war, we shall face another, no less vicious, if less far-flung. For the "peace-at-any-pricers," in hiding for the nonce, will flock forth to jam the council tables, demanding universal amnesty for the vanquished, dissolution of the armed forces, and the wholesale obliteration of every manufactory of munitions. These Quislings in our midst must be dealt with even more sternly than the Nazi and the Jap. Ties of blood and friendship must be forgotten. For if they prevail, freedom perishes. Johnson and Haven have told us how to build for permanent

F. L. JACOBS CO.

DIVISIONS

★

AIR-TRACK MANUFACTURING CO.

COLLEGE PARK MARYLAND

★

GRAND RAPIDS METALCRAFT CO.

GRAND RAPIDS MICHIGAN

★

PARTS MANUFACTURING CO.

TRAVERSE CITY MICHIGAN

★

F. L. JACOBS CO.

MAIN PLANT

DETROIT, MICHIGAN

MEEHANITE CASTINGS
will solve your problems involving STEEL, BRONZE and other SPECIAL MATERIALS

THE MEEHANITE METAL CORPORATION

To help you overcome difficulties caused by the shortage of certain special metals, The MEEHANITE Metal Corporation maintains a staff of engineers and technical experts to advise as to where and how MEEHANITE Metal can be used to advantage.

MEEHANITE is a cast metal combining the important advantages of both cast iron and steel. Produced under close metallurgical control, it is made in several types to meet various requirements such as high strength; free machinability; resistance to corrosion, wear, heat; adaptability to heat-treatment and flame-hardening.

MEEHANITE foundries are strategically located to serve principal manufacturing areas.

Send for this factual handbook, that tells what MEEHANITE is; how it differs from other metals, how and where it can be used to advantage. Sent free to executives, designers, engineers.

THE MEEHANITE METAL CORP.
311 Ross Street, Pittsburgh, Pa.

Book Reviews

victory. Theirs is a message for all to read, mark, learn, and inwardly digest! G. C.

COMMANDO ATTACK. By Gordon Holman. New York: G. P. Putnam's Sons. 258 pp. $2.50.

GORDON HOLMAN, an English newspaperman, was an eye-witness to Commando attacks by picked units of his fellow countrymen on two occasions—first in the Lofoten Islands (December 1941) and again at St.-Nazaire (March 1942). In the earlier instance, Norwegian Commandos collaborated in the operations against German forces occupying their homeland. In the latter, all the expeditionary troops were British.

Mr. Holman has given us an excellent account of the whys and wherefores of Commandos, the training they undergo, their special armament and other equipment, and their mode of conducting operations. Each unit contains elements from both Army and Navy, with the R.A.F. in full coöperation. By split-second timing, the ablest of leadership, and the selection of soldiers and sailors possessed of unbounded initiative combined with the ability to modify instantly, when circumstances so indicate, all preëxisting plans, it already has been possible for Britain to give the Nazis a number of unpleasant quarter-hours with more presumably in store. The very knowledge that further similar blows are likely anywhere, anytime, cannot but cause constant tension among the Germans, while the proud record of Commando accomplishments thus far remains a source of no small satisfaction to the English.

Another necessary attribute of a commando soldier is physical stamina. Characteristic is the following: "We did sixty-three miles in a little over sixteen hours. We were in full marching order. The only thing that worried the men was that most of them had arranged to go to a dance in the evening. We arrived in time for the dance, much to their satisfaction, and they finished up with several hours dancing." Again: "There I was, swimming rivers in Scotland in November (in full kit)—me, mind you, who never went to the public baths at home, except in August!"

The Commandos take their work (but not themselves) seriously. During maneuvers, "when transport was required, it was the nearest car that went, whether it belonged to an officer who protested that he was not taking part in the maneuvers, or to a general or even a Royal personage, as happened on one occasion." But as for being singled out for special consideration, they will have none of such. They are British soldiers and sailors —that is enough! To Admiral of the Fleet, Sir Roger Keyes, to whose efforts the Commando troops of the British Army owe their existence, a salute! N. D.

THE MUZZLE-LOADING RIFLE THEN AND NOW. By Walter M. Cline. Huntington: Standard Printing & Publishing Company. 162 pp. $7.

WALTER CLINE was one who richly merited whatever decoration for distinguished service the rifle gods find suitable for bestowal upon their most faithful servants. He was of that small but devoted band which has succeeded in reawakening among thousands of red-blooded Americans a love of shooting as an end in itself, rather than as a means to an end. We of today look upon the rifle as a highly efficient, highly standardized gas engine with which, after suitable preliminary practice, the average person may enjoy the thrill of establishing a creditable record at the target, bringing game to bag, or, under sterner circumstances, dispatching an enemy. Our rifles are precision products, all of a given make, model, caliber, and series, being fashioned so identically that every part is interchangeable. By the same token it is difficult for any single piece to acquire an individual "personality".

But with the muzzle-loader we enter a new world. Each

Book Reviews

specimen expresses the individuality of its maker. In the hands of a sympathetic user it comes as close to achieving animation as any product of wood and steel can. While the modern repeater with its almost foolproof mechanism, its oilproof and waterproof ammunition, and its rust-free primers gives relatively uniform performance in the hands of any but a tyro, the muzzle-loader is a coquette to be wooed assiduously if she is to respond at all. Her every mood must be made the subject of deep study. One specimen will do best on a certain grain and weight of powder plus a ball of given size and composition. Another of like caliber, bored and rifled by the same hand and in the same fashion, will require entirely different doses of powder and lead to achieve like results. A center "bull" or a clean miss may hang upon such fine threads as the fabric, weave, and thickness of the patch, the manner of lubricating this and of cutting it off, the way the ball is rammed home, the shape and diameter of the nipple vent, the intensity of the cap flame, and a hundred other variables each of which makes the game more difficult—and more fascinating.

The reviewer appears to have commenced, in the lines above, a dissertation of his own on the muzzle-loader. He need go no further. For a better one, in the form of Mr. Cline's volume, is now available.

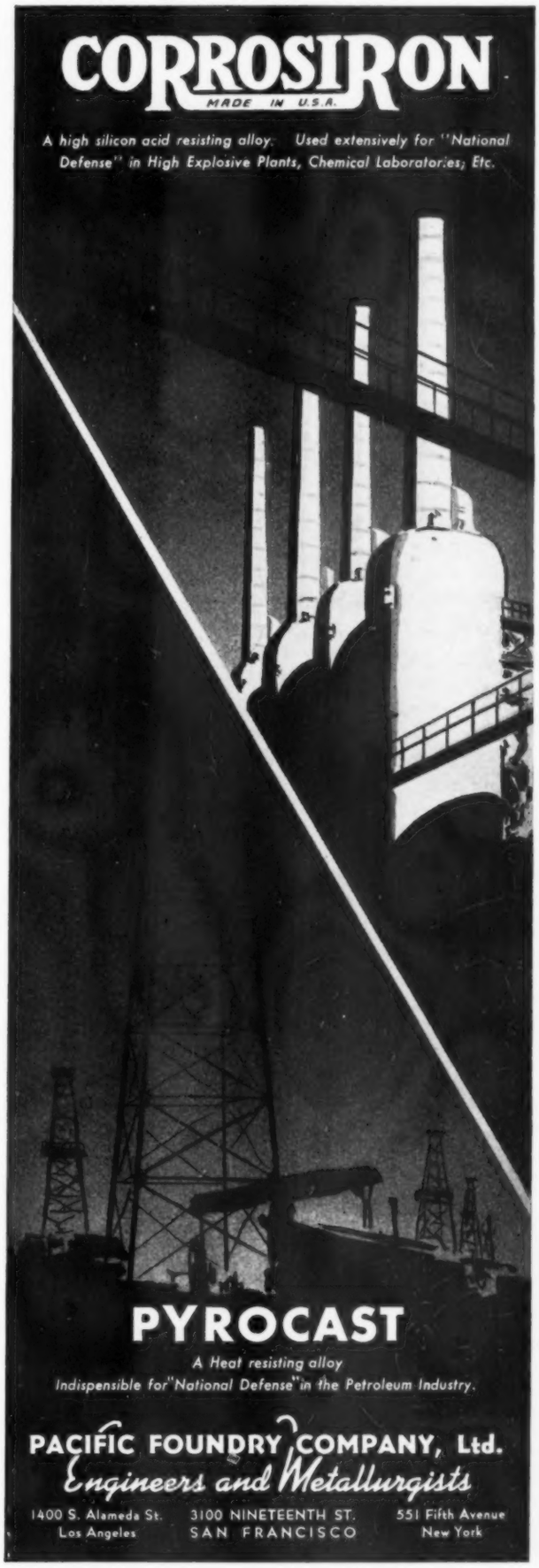
All within whom a whiff of black-powder smoke, curling upward from the muzzle of a long rifle, unleashes boyhood visions of Deerslayer in coonskin cap and fringed jerkin, of days to come when the boy, now man, will equal and surpass the legendary feats of that immortal character—all who eagerly yearn to exchange production-line similitude for rugged individualism will do well to look within the covers of Mr. Cline's work. There's lots of good red meat there. C. G.

BLUEPRINT FOR VICTORY. By Homer Brett. New York: D. Appleton-Century Company, Inc. 215 pp. $1.75.

MR. BRETT'S little volume concludes with a feature rather unusual in a handbook of this type—an 11-page alphabetical index. To the casual observer, this "extra added attraction," to ape the language of the showman, would betoken either an effort to dress up an inferior offering—or make a good one better. Happily, the latter is the correct reason. Mr. Brett was for thirty years (1911-1941) in the American Foreign Service, his duties carrying him hither and yon across the seven seas. The urge to write this book—followed by the act itself, was born as follows (pp. 164-165):

> In February 1941, I was talking with an admiral who has served more than forty years in the United States Navy. He had been telling me about the Aleutian Islands and remarked that Attu, the westernmost of them, is in the Eastern Hemisphere and that the Japs probably know more about it than we do, although it is American territory.
>
> I innocently asked, "How strong is Paramushiru?"
>
> "What is that?" he replied. "I don't know anything about it."
>
> "Perhaps I pronounced it wrong," I said. So I wrote the name out on a menu card.
>
> "I'm sorry," he replied after reading, "but it means nothing to me."
>
> "Admiral," I exclaimed in astonishment, "Paramushiru is Japan's northernmost fortified port and air station in the Kurile Islands, and it is five hundred or a thousand times as important to Japan as Pearl Harbor is to us, for Pearl Harbor is 2,200 miles from our western coast while Paramushiru is only about 1,500 miles from the very heart of the Japanese Empire. . . ."
>
> The incident emboldened one to write this perhaps presumptuous essay.

Mr. Brett has a plan for carrying on the second World War, but a second front in Europe or Africa plays no part in it. His plan is first to strike Japan where she is relatively weakest—in her merchant tonnage and military planes, both of which are being whittled down faster than they can be replaced. He would do this *now*, while these conditions exist, and before Japan, by some unlucky accident for the United Nations, manages to cancel


CORROSIRON
MADE IN U.S.A.
A high silicon acid resisting alloy. Used extensively for "National Defense" in High Explosive Plants, Chemical Laboratories, Etc.
PYROCAST
A Heat resisting alloy
Indispensible for "National Defense" in the Petroleum Industry.
PACIFIC FOUNDRY COMPANY, Ltd.
Engineers and Metallurgists
1400 S. Alameda St. Los Angeles
3100 NINETEENTH ST. SAN FRANCISCO
551 Fifth Avenue New York

ORDNANCE INSPECTION Gages

for— controlling dimensions of machined workpieces

GUN BORE GAGES

Both improved and entirely new gages are available equipped with Federal Dial Indicators. These gages are not only more accurate, but they are more positive and much faster. Sure, dependable speed is essential to efficient inspection of war material. Better performance is possible as well as better production. Write to

FEDERAL PRODUCTS CORPORATION
1144 EDDY ST. PROVIDENCE, R. I.

SHELL GAGES
This gage checks concentricity of BOTH inside and outside diameters simultaneously.

Checks both "lands" and groove diameter at various size gun bores.

Checks diameter and depth of groove in recoil cylinders. Below — Dial Indicator Snap Gage.

FEDERAL
PRECISION MEASURING INSTRUMENTS
Chicago · Cleveland · Detroit · Hartford · Los Angeles · Milwaukee · Montreal · Newark
New York · Philadelphia · Pittsburgh · Rochester · San Francisco · St. Louis · Toledo · Toronto · Windsor

Book Reviews

her shortages in one or both. He would do it largely by attrition, as far as the shipping is concerned, and, with respect to airplane power, by air action on the grand scale.

And now, to the kernel within the nut: "The theme of this book is an American attack in force along the Aleutian-Kurile Islands. But already we can and we should bomb Japan. From Dutch Harbor to Tokyo and back is a little less than six thousand miles. . . ." Obviously we should, and must, recover the lost units of the Aleutian chain. From them we can strike at Japan's ships of the sea and ships of the air. Massing naval and air armadas of our own in their vicinity, we can choose our own time and place for all-out engagements in both elements. And if we will but forsake for the time being our ideas of defending all points in North and South America, and shift to the Aleutians the strength in ships and planes now required to "defend" these against an enemy that cometh not, the outcome is all but assured. Mr. Brett presents a strong case in pleasing form. We recommend his book—it's worth a few hours of any man's time. D. N.

THE BULLET'S FLIGHT. By Franklin W. Mann. Huntington: Standard Printing & Publishing Company. 384 pp. $6.

TO the arms enthusiast, Dr. Mann's volume, first published in 1909, and now reprinted and enlarged by the inclusion of two short biographical sketches of the author, needs no introduction. That gentleman's standing in the scientific world has long been unquestioned, and the importance of this, his signal contribution to the fascinating study of exterior ballistics, is universally conceded. That Dr. Mann lived and wrote before his time and died disappointed and somewhat embittered by the lack of public appreciation of his painstaking experiments, carried out at such considerable expense in time and treasure, is lamentable. But such is the characteristic fate of many a pioneer.

Mann's experiments with small arms dated from his adolescence, and ended only with his death in 1916. Commencing at the age of 12 with a caliber .44 muzzle-loading affair, his first, and lifelong, objective was to discover why, with conditions for successive shots as nearly uniform as possible, each bullet could not be made to pass through the same hole in a target placed at reasonably close range.

What conclusions the worthy doctor reached are expounded within the covers of his delightful volume. In it are recorded, chronologically, the results of his carefully controlled experiments from July 1894, when they were first seriously undertaken and recorded, to December 1908. One hundred and eighty-four different tests are described and the resultant findings discussed and analyzed. Many are the factual trophies he has passed on to us in "The Bullet's Flight." It is a matter of rejoicing that they are now made more generally available to a new and, let us hope, more appreciative generation. C. G.

SPECIAL EQUIPMENT
for
MANUFACTURE OF AMMUNITION

PETERS ENGINEERING COMPANY
PHILADELPHIA, PA.